

Annual report

1955

LAKE STATES FOREST EXPERIMENT STATION

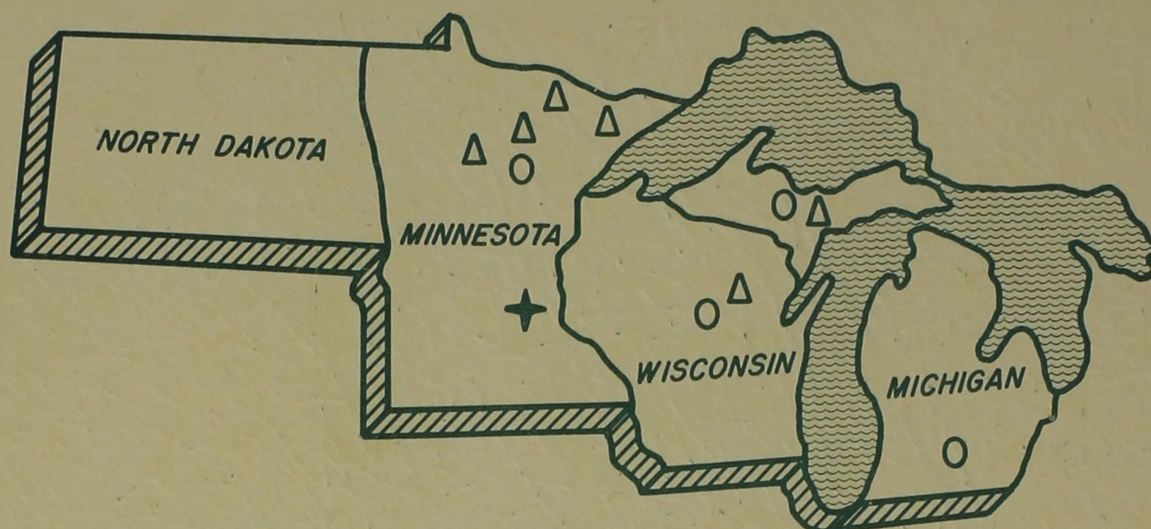
- ST. PAUL, MINNESOTA
- M. B. DICKERMAN, DIRECTOR




U. S. DEPARTMENT OF AGRICULTURE  
FOREST SERVICE .....





TERRITORY SERVED BY THE  
**LAKE STATES FOREST EXPERIMENT STATION**  
 ST. PAUL, MINNESOTA



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-  Research Centers
-  Experimental Forests

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 Forest Utilization  
 Forest Insects  
 Forest Diseases  
 Wildlife Research

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\* \* \* \* \*  
 \* The Lake States Forest Experiment Station is \*  
 \* located on the St. Paul Campus of the University \*  
 \* of Minnesota. It is a regional office of the \*  
 \* United States Forest Service and is maintained \*  
 \* in cooperation with the University of Minnesota. \*  
 \* Through federal legislation, it is authorized to \*  
 \* carry on forest research for the benefit of all \*  
 \* forestry agencies in the region, including public \*  
 \* forest services, wood-using industries, farmers, \*  
 \* and other forest owners. \*  
 \*  
 \* The territory in which the Station operates \*  
 \* includes the States of Michigan, Wisconsin, \*  
 \* Minnesota, and North Dakota. In addition, the \*  
 \* Station is responsible for forest and insect \*  
 \* surveys of eight central states: Ohio, Indiana, \*  
 \* Illinois, Kentucky, Iowa, Missouri, Nebraska, \*  
 \* and Kansas. Besides the central office in St. \*  
 \* Paul, field offices are located at East Lansing \*  
 \* and Marquette, Michigan; Wausau, Wisconsin; and \*  
 \* Grand Rapids, Minnesota. \*  
 \*  
 \* \* \* \* \*



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# 32nd      A N N U A L      R E P O R T

## LAKE STATES FOREST EXPERIMENT STATION

for the calendar year 1955

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### I N T R O D U C T I O N

This was a year of consolidating gains made in 1954 and of acquiring a better understanding of the timber economy of the Lake States region. The large expansion of research projects and personnel initiated the previous year took definite shape in terms of many new studies in forest insects, forest genetics, utilization, and marketing. The Timber Resource Review, released by the Forest Service in October as a preliminary draft, gave a new picture of what the needs for research are, of the more acute problems relating to the productivity of forest land, and of the outlook for future requirements for timber. This "new look" gives a much needed base for orienting the research activities in the second half of the Twentieth Century.

Highlights from the Timber Resource Review as they pertain to the Lake States region, brief mention of some important Station activities during the year, and a discussion of additional research needs are summarized on the next few pages. The remainder of the report contains more detailed review of current major projects in the various fields of forest research together with some of the findings and of plans for 1956. A list of Station publications in 1955 is given at the end of the report.



HIGHLIGHTS OF THE  
LAKE STATES  
TIMBER SITUATION

The Timber Resource Review contains the results of a nationwide timber survey conducted by the Forest Service in cooperation with numerous State, County, and private agencies.

Briefly, some of the more significant points brought out about the Lake States region are:

Regional demand for timber products may be expected to increase sharply.--Rapidly rising population and, for pulpwood, a rising per-capita use, are listed in the TRR report as reasons for possibly doubling (or at least increasing by two-thirds) the consumption of wood in the Nation by 2000 A. D. The States of this region fall far short of self-sufficiency in lumber and woodpulp and most other wood products. They will need to increase the output of their forests greatly to keep up with the expanding economy.

Forest inventories show some gains and some losses during the past 15 to 20 years.--Estimates, based upon recent surveys, compare with 1936 survey figures about as follows:<sup>1/</sup>

	<u>1936<sup>2/</sup></u>	<u>1953</u>	<u>Change</u>
<u>Area</u>	(Thousand acres)		
Gross forest area	55,634	55,201	-433
Commercial forest area	53,328	53,272	-56
Sawtimber area	6,984	6,457	-527
Poletimber area	10,612	16,010	+5,398
Seedling and sapling areas			
Satisfactorily stocked	12,722	15,672	+2,950
Poorly stocked	12,438	4,698	-7,740
Nonstocked area	10,572	10,435	-137

Volume of standing timber

	(Million cu.-ft.)		
Total growing stock	21,170	25,218	+4,048
Softwoods	8,110	6,543	-1,567
Hardwoods	13,060	18,675	+5,615

	(Million bd.-ft.)		
Sawtimber volume	53,500	49,790	-3,710
Softwoods	20,400	14,355	-6,045
Hardwoods	33,100	35,435	+2,335

<sup>1/</sup> Data are for Michigan, Minnesota, and Wisconsin.

<sup>2/</sup> Adjusted to eliminate noncommercial tracts and to put volume estimates on same basis as 1953.





The improved stocking and increasing growth on Lake States timberlands are illustrated by these two pictures. In 1936 there were 12 million acres of poorly stocked seedling and sapling stands (top photo). Today many of these stands have filled in and are approaching pole size (bottom photo). Much of the new growth is on trees too small to harvest yet, and too large a proportion is of hardwood species, but more timber is growing than is being cut.





Timber growth is increasing.--On a national basis, both sawtimber growth and growth in cubic-feet are greater than in 1944. In the Lake States region prospective growth appears larger than in previous years and now exceeds recent annual drain as shown by the following figures:

	1936 <sup>3/</sup>		1953	
	<u>Growth</u>	<u>Drain</u>	<u>Growth</u>	<u>Drain</u>
<u>Growing stock</u>	(Million cu.-ft.)			
Total	813	661	1,180	537
Softwoods	190	279	319	188
Hardwoods	623	382	861	349
<u>Sawtimber</u>	(Million bd.-ft.)			
Total	1,470	2,090	2,693	1,240
Softwoods	451	790	802	384
Hardwoods	1,019	1,300	1,891	856

In most situations the present softwood growth surplus is not found on trees of sufficient size and maturity to suggest immediate expansion of cut, but many places offer opportunities for increased cut of hardwoods.

Timber quality is declining.--This is shown by the large proportion of total volume found in cull trees and in trees of small diameter. It is shown also in the decreasing proportion of No. 1 logs recorded in successive surveys in the Lake States region.

This general decline in sawtimber quality creates serious problems both in forest management and in timber marketing.

	Percentage of sawtimber volume in No. 1 logs	
	<u>1936</u>	<u>1953</u>
Sugar maple	26	18
Yellow birch	36	15
Basswood	29	21
Elm	27	17
Beech	19	5
Oak	16	12
Aspen	5	9
Soft maple	13	4

Insects and disease take high toll.--Annual losses from destructive agents are estimated to average 485 million cubic-feet, about 90 percent as much as the annual cut. Nearly 34 percent of these losses are caused by diseases, 7 percent by insects, and 1 percent by fire; the remainder is caused by other agencies or combinations of agencies, of which wind is the outstanding factor.

<sup>3/</sup> Adjusted to 1953 standards of measure.

Forest productivity is the poorest on small farms and other small private ownerships.--Forest productivity has shown considerable improvement on the 21.4 million acres of public lands and on the 3.0 million acres of forest industry ownerships since the last survey. But much of the farmwoods, which include 15.2 million acres, and much of the 13.6 million acres of "other" private ownership are neglected. Inadequate stocking, excess of cull trees, excessive losses from natural causes and from pasturing, and lack of management plans are the commonest shortcomings.

Large acreages need planting.--An estimated 8.4 million acres or 16 percent of the commercial forest area need planting in the Lake States. This consists of about 0.5 million acres of federal land, 1.4 million acres of state land, 0.7 million acres of county and municipal land, and 5.8 million acres of private land. Included in the latter figure are 0.6 million acres of shelterbelts and other plantable sites not strictly of a forest nature.

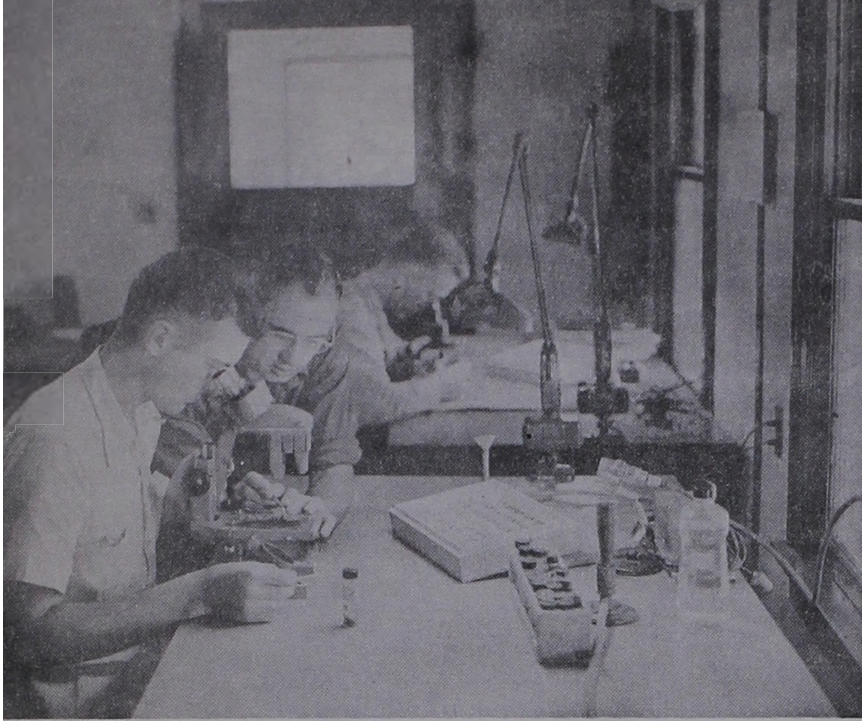
Cooperation increasingly important.--On the whole, the Timber Resource Review indicates that the forest situation in the Lake States has improved in the past 2 decades. The reasons for the changes are many and involved. But one factor is of transcendent importance--the growing realization by the people and by industry of the need to use our forests wisely and to place them on a sustained yield basis. Increasing cooperation among public and private research groups has played and will continue to play a vital role in increasing the productivity of the Lake States forests.

NEW STATION      As our forests change, so too must the emphasis in  
ACTIVITIES      research. Only in the past 2 years has work in for-  
IN 1955          est genetics, insects, disease, marketing, and util-  
                 ization become an important part of the Station's  
program. In 1955 a number of new projects in these fields were be-  
gun.

Establishment of insect field laboratory.--During the early part of 1955 a field laboratory for conducting research on forest insects was established near Ely, Minnesota. Studies were started on the spruce budworm, an insect which threatens the vitally important spruce and balsam fir in this region.

Blister rust as affected by microclimate.--White pine is attacked by a parasitic fungus that causes blister rust and frequently results in severe damage, especially in young stands. Recent studies indicate that infection takes place only where topography and vegetation encourage the accumulation of cool, moist air. A research study, initiated this year by the Station in cooperation with the University of Wisconsin, seeks to develop a method of predicting





Forest insect field laboratory near Ely, Minnesota. Entomologists are examining balsam fir twigs for spruce budworm egg masses.

the occurrence of these conditions. Thus it may be possible to determine in which areas the risk of growing white pine will be at a minimum.

Site for genetics center chosen.--One of the aims of forest genetics research is to define the characteristics of superior trees for use of foresters in seed collection and timber marking. Another is to develop hardy, fast-growing stock of high quality that is resistant to insects, disease, and other enemies. This year a site near Rhinelander, Wisconsin, was chosen for a forest genetics center. Construction of a greenhouse, laboratory, workshop, and other facilities is under way.

Studies on utilization of low-grade hardwood material expanded.--Good management of northern hardwood timber in the Lake States is hampered because most of the material that should be removed in improvement cuttings--small-diameter or cull trees and inferior species--cannot be marketed profitably. The Station is approaching this problem from several angles. Two studies, mentioned in our report for 1954, are now in full swing: One concerns the use of low-grade material to produce uniform, high-quality charcoal; the other seeks to develop guides for appraising quality of northern hardwood timber as a basis for management and sale. Other studies begun in 1955 include (1) evaluating currently unacceptable species and grades of timber for sawn products other than lumber and developing processing and handling techniques, (2) determining logging costs and expense of bark removal for low-grade oak compared to those for aspen, (3) analysis of the amount of damage to the residual stand caused by various logging methods and equipment, and (4) evaluating logging residue in the northern hardwood type preparatory to developing more intensive use.



Soil-site studies for major species.--Fundamental research on the relation of forest soils to the growth needs of various tree species has been neglected. The Station is now beginning a series of projects in soil-site relationships so that in the future more emphasis can be placed on planting or getting reproduction of a species on the correct soil type.

Analysis of watershed problems.--Soil erosion, floods, inadequate moisture for crops, and an insufficient supply of clean water for domestic and industrial use are problems which are receiving increasing attention throughout the Nation. This year the Station, in cooperation with Michigan State University, began a study of the character, extent, and relative importance of such problems in this region. From the results of this study, a program can be developed on specific research needs in watershed management.

Group meetings encouraged.--To make the best possible use of skills and facilities, various research groups should keep in touch with the activities of others. The Station, because of its regional scope, feels a special responsibility for facilitating coordination and the flow of information. This year we were active in arranging meetings for four groups interested in special fields of forest research.

1. The Lake States Forest Insect Survey Conference discussed the development of uniform methods for appraising and reporting the abundance of the more important forest insects in the region, and adopted uniform survey procedures for several of the surveys.
2. Forest products marketing research personnel from four institutions met with the Station staff to report the status of research under way in this field and to exchange suggestions for future studies.
3. An Aerial Brush Control Meeting, attended by representatives of chemical and aerial spraying companies, forest managers, and researchers, provided an opportunity for discussion and demonstration of the most recent developments in the control of brush by aerial spraying of chemicals.
4. The Second Lake States Forest Genetics Conference was attended by over 70 foresters working in the field of forest tree improvement. Recent progress and new techniques in genetics research were discussed and some of the possibilities for further research examined.

Changes in technical staff.--The Station's research program has been strengthened by a number of additions to the technical staff. J. L. Bean, who has had wide experience in insect research and is a specialist on aerial surveys, was appointed to the forest insects



staff. Dr. Hans Nienstaedt joined the forest genetics staff; his experience on the chestnut and hemlock breeding programs should be turned to good account in the Station's new program. Dr. John Parmeter was added to the forest disease staff. He is handling the project on microclimate and its relation to blister rust on white pine. Other new personnel include Loyd LaMois in fire research; L. J. Arasim, forest survey; and C. E. Boldt, R. E. Buckman, R. M. Marden, P. E. Slabaugh, G. E. Sprenger, and P. L. Thornton, on management-utilization problems. C. E. Westell resigned during the year to accept a position as forester with the American Box Board Company in Michigan.

On educational leave.--Members of the technical staff are encouraged to take extended leave to obtain advanced training in their special fields of research. The following five men are now doing post-graduate work at various forestry schools: D. R. Cowan, D. N. Quinney, M. L. Heinselman, J. D. Burton, and A. H. Westing.

Cooperative aids stimulate progress of forest research.--Research in forestry, as in many other fields, has tended more and more to become a cooperative effort, with many agencies participating. Sometimes two or several agencies work side by side on a problem. And occasionally funds are turned over to the Station by another research group, to be used on a specific study. In recent years the Station has allotted funds, mainly to educational institutions, for assisting on special research jobs. Such "aids" were provided in 1955 for the University of Minnesota, University of Wisconsin, University of Michigan, Michigan State University, and the Michigan College of Mining and Technology.

Throughout this Annual Report it will be noted that many of the studies are conducted with the assistance of the forestry schools, conservation departments, and other public and private agencies. This cooperation, which the Station gratefully acknowledges, has immeasurably increased the progress of forestry research in the Lake States region.

LOOKING TO       As encouraged as we may be by the forward strides in  
THE FUTURE       the regional research program and in the "bettering"  
                  of the timber situation, there are obvious voids and  
weaknesses in certain areas of research. Some of these are mentioned briefly here.

Intensified and expanded work in forest diseases.--Diseases account for a large part of tree mortality in this area. Present Station funds, though, are sufficient to employ only two pathologists. Work on hypoxylon canker, the most serious disease of aspen known, needs to be intensified; this disease is especially important in



the Lake States region with its extensive aspen stands. More information is needed on the relation of site conditions and management practices to decay. Other needs include disease studies in plantations and in heart rots of hardwoods.

Insect attacks on plantations require study.--In the past several decades about 2 million acres in the Lake States have been planted to trees--mostly conifers--and additional areas are being planted each year. As a potential source of timber for our forest industries, these plantations must receive more protection. They are peculiarly subject to heavy insect attacks. Although progress has been made in our research on the biology and control of some important forest insects, a greater effort is needed. Especially urgent is work on the European pine shoot moth, the white-pine weevil, and the sawflies.

This 27-year-old Minnesota red pine plantation, ready for its first commercial thinning for pulpwood, has reached an age when serious damage from insects is unlikely. Evidence from other regions, however, indicate that at this stage of growth plantations are especially vulnerable to disease.





Broadened effort in the Upper Peninsula of Michigan.--The prosperity of the Upper Peninsula of Michigan depends largely on proper management of its forest lands, for 87 percent of the area is forested. One of the major problems is in hardwood sprout stands on areas clear cut near the turn of the century. Large areas of these second-growth hardwood lands are now producing inferior, poor-quality trees, and some areas are covered with worthless brush. The problems of managing coniferous stands for pulpwood growth also need attention. Guidance should be provided on how to thin, harvest, reproduce, and manage these lands, and on how to utilize and market the products to best advantage.

Planting in the Plains of North Dakota.--In North Dakota trees have great recreational and aesthetic values. They also protect farmsteads, livestock, and crops, and conserve the soil. Studies of tree planting for the Great Plains region were carried on vigorously during the thirties, but were discontinued during World War II. These studies should be resumed. There is a widespread demand in North Dakota for information on what trees to plant and how to grow them successfully under specific soil and moisture conditions.

Basic research in watershed management.--Although the preliminary analysis of watershed problems in this region is as yet incomplete (see page 63), indications are that basic research is needed on water yields and on the value of trees and brush cover for controlling water, that is, the effects of various species and mixtures of species and of degrees of stocking in promoting rapid infiltration of moisture into the soil. This region has always been fortunate in possessing abundant water supplies. Steps should be taken to insure that this abundance will continue as the demand for water continues to increase.

Prosperity based on research.--Research is a never-ending job. Rarely is it possible to say, "We have learned all we need to learn on this subject." On the contrary, the solution to any specific problem generally reveals several more questions requiring answers. That this is true is fortunate, for the American way of life is based on continuously uncovering better methods of doing things. When we cease to learn, our economy will become static and our standard of living will stop rising. Forest research in the Lake States, once confined mainly to management studies, fire problems, and analysis of timber resources, is probing deeper into other areas of study that will reap rich rewards for our region--genetics, utilization, forest entomology and pathology, and forest influences. As our timber resource situation and general economic conditions continue to change, emphasis in various fields of forest research must shift. Thus, continuously gauging progress and looking to the future for what we should be doing next are essential attributes of a sound research program.

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## F O R E S T     E C O N O M I C S

The Division of Forest Economics deals primarily with statistics and analyses relating to forest resources and to the forest industries utilizing these resources.

One phase of its work, the Forest Survey, aims to compile the best available estimates of forest area, timber volume, growth, allowable cut, and drain for lands of all ownership in each of the states. This Survey is concerned also with the current rate of consumption of forest products, and is engaged in some investigations of trends to help forecast future timber needs.

Going on from the resource data, the division makes industry analyses, attempting to determine how well the industrial capacity is integrated with available resources, where surplus raw material exists, and where shortages of particular species or grades of wood may be impending.

Another line of investigation is in marketing of forest products. Forest surveys have indicated a general surplus of low-grade hardwoods and local surpluses of other kinds of timber. Increased use of these materials hinges upon markets. The division is attempting to explore potential markets as a step toward increased utilization.

The field of forest economics embraces many problems in the business aspects of forest management--particularly the costs and returns from various forestry operations. The Station does a certain amount of work in this field as conditions permit. It hopes eventually to give much more attention to this important activity.

FOREST     The Survey as conducted in this region is a large coop-  
SURVEY     erative undertaking in which the combined contribution  
            of states, counties, landowners, and others has exceeded  
the financial contribution of the Station more than two to one.  
The efforts of the Station have been directed toward such project  
planning, studies of technique, survey field work, computations,  
and writing of local reports as were necessary to supplement the  
work of cooperators. An important function has been the standard-  
ization of procedures and coordination of activities. The Station  
has also made the compilation and analysis of local data needed  
to provide state summaries for national resource reviews.



The status of the Survey is shown by the accompanying map and table, and is discussed for those states where work is under way.

Status of the Forest Survey  
December 31, 1955

State	Forest area	Proportion of job done		
		Total job	Field inventory	Reports
	<u>M acres</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>
Initial survey				
Illinois	3,996	100	100	100
Indiana	4,103	99	100	95
Iowa	2,620	88	100	20
Kentucky	11,497	100	100	100
Missouri	15,187	100	100	100
Nebraska	1,073	66	100	0
North Dakota	467	73	100	0
Ohio	5,446	98	100	90
Maintenance survey				
Kansas	1,121	13	25	0
Michigan	19,300	67	96	26
Minnesota	19,344	98	100	95
Wisconsin	16,500	49	68	19
All states	100,654	83	93	66

Minnesota Moving Toward  
Continuous Inventory

The first Minnesota forest survey was completed in 1936 and the second in 1954. A state statistical summary from the second survey was issued by the Station in 1954, and detailed county reports have been published for most northern counties by the Iron Range Resources and Rehabilitation Commission.

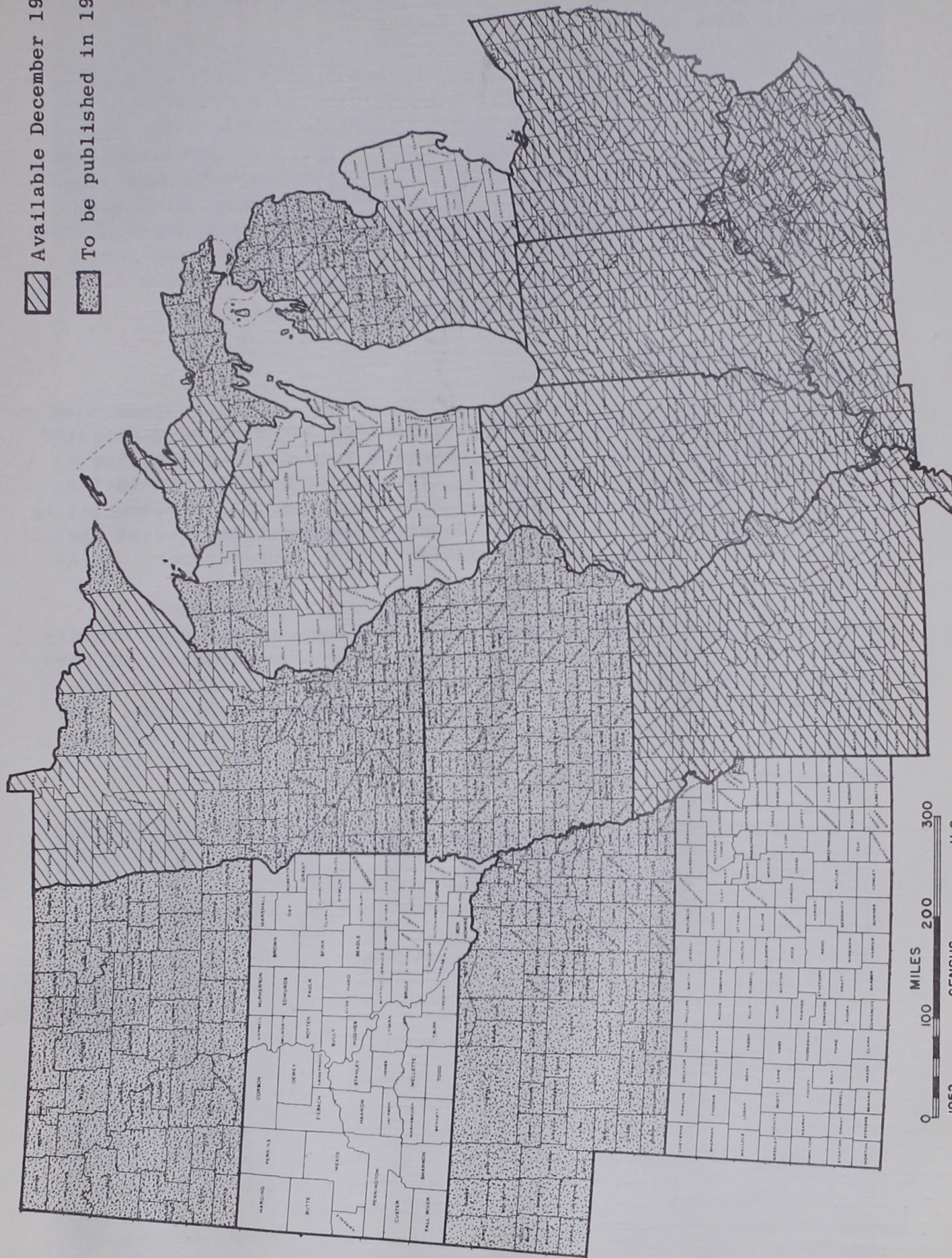
These reports have focused attention upon the opportunities for the expansion of present industries and the introduction of new wood-using industries in Minnesota. In spite of overcutting in locations close to milling centers and main highways, the State offers substantial surplus volumes in some more distant localities. Much of the surplus consists of aspen, but it includes considerable pine and some spruce and fir. The findings already have



# STATUS OF FOREST SURVEY REPORTS

Available December 1955

To be published in 1956





aroused a great deal of interest and can be expected to effect a number of changes during the next decade.

To keep in touch with the changing situation, the State of Minnesota has initiated a system of continuous inventory for state lands. Most northern counties also have set up cutting budgets and plan to make resurveys of county lands as needed. National forests expect to keep their resource data current. The Iron Range Resources and Rehabilitation Commission and the Station are experimenting with continuous inventory systems to sample trends in other areas. Thus, by joint action, it is hoped that the resource information for Minnesota can be kept reasonably well up to date until such time as a complete reinventory becomes necessary.

#### Wisconsin Appraising Planting Needs

The resurvey of Wisconsin's forest resources moved ahead during the year. Individual reports for 11 counties were published by the Wisconsin Conservation Department. Five other reports are in the process of review or publication. Present plans call for completing the inventory of the 32 northern counties during 1956, and of the more lightly forested farming counties in the southern part of the State during the following year.

One aim of the Wisconsin forest survey has been to appraise broadly the need for forest planting in each county. The inventory of forest land shows that rather large areas are poorly stocked or non-stocked with trees, but not all of these areas need planting. The report for Clark County, for example, showed 48,880 acres of non-stocked or poorly stocked seedlings, but only 20,800 acres as definitely in need of planting.

Among the situations where planting is not recommended are: (1) Areas likely to become 40 percent stocked naturally within a 20-year period, (2) brushy lowlands where planting would be difficult and survival doubtful with present equipment, and (3) grazed woodlands where survival of trees would be very poor. After these discounts, however, the survey still shows rather large acreages of land in need of planting in most northern counties.

#### Michigan Puts Survey Data to Work

With field work from the current survey near completion, the participating agencies in Michigan have taken a number of steps to develop action programs based on the data. The Survey Steering Committee, which has served as an informal advisory group since 1947, has accepted responsibility for analyzing and publicizing the county and district situations and is working with county boards, civic groups, industries, and others who are in a position to act on their





Lowland brush site in Rusk County, Wisconsin, considered too difficult and unpromising to plant.

recommendations. In this way they hope to bring the timber harvesting into closer harmony with the productive capacity of the land. In many cases the survey data point to opportunities for new forest industries. The Survey Committee also is working closely with the Station on developing plans for keeping survey data current and up to date.

Federal, state, and industry foresters cooperate in taking stock of forest resources in Michigan. Picture shows crew making remeasurement of sample plot on state land to ascertain growth and mortality during past 5 years.







Typical cottonwood type in the Missouri  
River bottomlands in central North Dakota.

#### First Forest Survey Made of North Dakota

Only 1 percent of the area of North Dakota is forested, but in some half-dozen localities woods are sufficiently concentrated to assume some commercial importance. Of considerably greater significance are the thousands of shelterbelts and other plantings which shield homesteads, stockyards, fields, and rights-of-way from drying winds and drifting snow. These and other facts will be described in detail in the report now being prepared.

#### Nebraska Forests Appraised<sup>4/</sup>

Between 2 and 3 percent of the land in Nebraska is forested, according to the survey completed late in 1955. This area includes rather extensive plantations of pine in the Sandhills as well as some commercially valuable hardwood forests along the rivers in the eastern part of the State. Foresters from several divisions of the U. S. Forest Service, from the Soil Conservation Service, and from the University of Nebraska participated in this first complete inventory of forests and wood-using industries. A statewide report will be available in 1956.

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<sup>4/</sup> The State of Nebraska is in the territory of the Rocky Mountain Forest and Range Experiment Station and Region II of the Forest Service. However, responsibility for completing the forest survey is with the Lake States Forest Experiment Station.





One of many mills canvassed during survey of lumber production conducted for the Bureau of the Census in 1955. This is a typical medium-sized mill operating in northern Minnesota. The mill is electrically operated, with circular headsaw, trimmer, edger, and planer. Although most of the lumber is channelled to commercial markets, some custom sawing is done for local forest residents.

#### Iowa Inventory Completed

About 7 percent of the State of Iowa was shown to be in forest by the survey completed in the fall of 1955. Foresters from both the State Department of Conservation and Iowa State College participated with those from the Lake States and Central States Forest Experiment Stations<sup>5/</sup> in the inventory of woods and wood-using industries. Reports will be available in 1956.

#### Station Continues Production Surveys

As part of the forest survey project, the Station collects statistics from forest industries concerning the annual production. On alternate years it combines these into a regional "drain" report showing quantities of timber removed from the forest. No drain report was issued for 1955, but a great deal of production data was assembled.

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<sup>5/</sup> The State of Iowa is in the territory of the Central States Forest Experiment Station, but responsibility for the survey is with the Lake States.



In cooperation with the Bureau of the Census, a survey of lumber production for the year 1954 was made throughout the North Central Region. Results will be published by the Census early in 1956.

Wood receipts for all pulp mills in the Lake States were tabulated and published as Technical Note No. 436. One notable point was that Wisconsin's 1954 harvest of 691,000 cords was the largest ever recorded in that State. Species-wise, the cut of dense hardwoods increased about 10 percent over 1953. Imports from western states fell off by one-third.

A survey of veneer log production, summarized in Technical Note No. 442, showed that significant quantities of hardwood timber--principally maple, birch, and elm--are used by this industry in the Lake States. Michigan produced more veneer logs than the other two States, but Wisconsin mills consumed more.

Complete production and drain summaries covering all forest products were prepared for each of the county and district reports issued during the year.

INDUSTRY ANALYSIS      The Timber Resource Review pictures the possible demand for forest products by 2000 A. D. as ranging from 50 to 100 percent greater than actual consumption in 1952. At the lower level, the forests of the Nation will need 1/3 more sawlogs, 2½ times as much veneer logs, 2½ times as much pulpwood, and fully as much miscellaneous industrial timber as was cut in 1952. Only fuelwood demand is expected to decline.

This prospective rise in timber requirements poses serious problems for states in the North Central Region where lumber requirements already far outrun the capacity of the forest lands to produce. It suggests need for some very careful study of regional implications of demand trends and the relationship of several industries to their raw material supplies.

The States of this region probably cannot again become self-sufficient in sawlog products within the present century, but in smaller timber products, notably pulpwood, the prospects appear more favorable.

#### Pulp and Paper Industry Important

Approximately 218 paper mills and 139 pulp manufacturing plants operate in the North Central Region (classified by the industry as the Lake States Region). These mills employ close to 100,000 workers, pay some \$300 million in salaries and wages. Woods operations, trucking, rail hauling, etc. employ thousands of additional



workers part time. In many localities the industry, through payrolls, business expenditures, taxes, and other activities, is the backbone of community life.

Records maintained by the Station over a period of years show a steadily rising trend in output of products from the pulp and paper mills. They also give evidence that continuance of this expansion is going to depend upon the ability of the industry to adjust itself to the kind of forest resources locally available.

Forests of the region are now growing more timber than is being cut, and within the next 2 decades should have little difficulty in supplying sufficient wood fiber to double the present pulp yield. However, the prospective additional timber yields are primarily hardwood and vary from place to place in species composition. Softwoods show favorable prospects in a few locations, but are dependent upon the kind of management to which they are subjected.

The regional resource picture as related to the pulp and paper industry is analyzed in a publication to be released in 1956.

**MARKETING STUDIES**      Growth of hardwood timber in the Lake States is reported more than twice the current rate of cutting. Surpluses are available in aspen, oak, ash, and many other species. The surplus material is primarily of small size or inferior quality and thus presents problems in utilization and marketing. The marketing studies now conducted by the Station, therefore, are directed primarily at exploring markets for products made from low-grade hardwoods.

#### Twin City Pallet Study Nears Completion

A study of the pallet industry supplying the industrial needs of the Minneapolis-St. Paul metropolitan area was started in the fall of 1954. A report on this project is now nearing completion. Project emphasis was divided into three descriptive and analytical parts: (1) Pallet production, (2) distribution channels, and (3) use of pallets.

Since 1942 a pallet industry has been developing in this region. Today it is represented by more than a score of active manufacturers and is recognized as a valuable asset to the area's timber economy. Lower grades of hardwood lumber are the industry's primary raw material, thereby effectively providing for utilization of much low-quality material which is characteristically difficult to market. During 1954 the Twin Cities used an estimated 2.1 million board-feet of hardwood lumber in pallets. Approximately 90





Pallets made from low-grade hardwood lumber are used extensively in storage and distribution of food products in the Minneapolis-St. Paul area.

percent of this volume originated in the three Lake States of Wisconsin, Minnesota, and Michigan. Last year a conservative total of 25 million board-feet of lower grade hardwood lumber probably moved from Lake States forests into the manufacture of pallets.

Nationally, the pallet industry has emerged as the fastest growing user of lumber. The widespread acceptance of palletization by a large variety of industries has been due to the high efficiency, versatility, and adaptability of the system, which has resulted in sizable savings. Production for 1955 will exceed 42 million units (containing more than a billion board-feet of lumber) with a market value of approximately \$107,500,000.

#### Charcoal Marketing Study Started

The Station this year initiated a study of the domestic charcoal market, a study intended to complement the charcoal production research begun last year and covered elsewhere in this report. The chief objective is to estimate the size and nature of the charcoal market which is available to prospective kiln operators.

The domestic demand for charcoal has expanded rapidly during the past 5 years and now exceeds the industrial demand. The domestic market is nationwide and is locally accessible to the small producer. On the other hand, it is highly seasonal, with a great majority of all sales in this region occurring in the three summer months.



Marketing research personnel are sampling retail dealers within one State, Wisconsin, and requesting information on quantities of charcoal sold annually over a 5-year period, seasonal sales patterns, consumer preferences as to product form and packaging, prices, peak-season shortages, and available off-season storage facilities.

Summarization of this information for various areas of the State--urban-industrial, rural, and recreational--and for various types of retail stores will pinpoint Wisconsin's domestic charcoal market. Many of the conclusions will be applicable to the other States in the region as well.

PLANS            The work of the Economics Division in 1956 will be  
FOR 1956        largely a continuation of projects now under way.

In Forest Survey, greatest effort will be given to completion and publication of reports, including (1) regional summaries (Lake and Central States) of resource data included in the Timber Resource Review, (2) state statistical or analytical reports (Ohio, Minnesota, North Dakota, Iowa, Nebraska), (3) drain report (covering 1954) for Lake States and Missouri, and (4) local survey reports (in cooperation with State agencies) for Upper Peninsula of Michigan and 11 counties of Wisconsin. Field work will be continued in Michigan and Wisconsin. Techniques research aimed at improving methods for future surveys will be initiated as opportunities arise.

In Marketing Research, attention will be given to a broad problem analysis to guide future studies. The results of the pallet study will be published. The charcoal study will be brought to conclusion. Parallel work at the University of Minnesota and the University of Michigan will be supported. Opportunities for collaborating with the University of Wisconsin and Michigan State University will be explored.

In Industry Analysis, results of the study of the timber supply problems of the pulp and paper industry in this region will be published.

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## F O R E S T     P R O T E C T I O N

Adequate forest protection has always been one of the major objectives of forest owners and managers. Until a few years ago Station research in this area of study was concentrated on fire detection, prevention, and control. As fire losses diminished, attention has gradually shifted to studies on insects and diseases, which have replaced fire as major threats to our forests. Wildlife studies are also considered a part of our protection research. These have a twofold purpose: (1) To maintain populations at a maximum consistent with other forest uses, and (2) to improve shelter and food supplies.

FOREST            Annual losses of timber due to forest diseases in the  
DISEASES        Lake States are four times that of fire and insect  
                 losses. Or stating it another way, 84 percent of the  
annual mortality of timber from insects, diseases, and fire in  
Minnesota, Michigan, and Wisconsin is due to tree diseases. Growth  
loss plus mortality shows a total impact on the timber resource of  
1,840 million cubic-feet, more than in any other northern region  
of the United States.

Such large losses in growth are due, to a very large extent, to the decay in hardwoods resulting from heart rots and the Hypoxylon canker of aspen. Other diseases of importance in the Lake States are blister rust, oak wilt, mistletoe, and the heart rots of conifers.

The Station's program to develop measures for reducing the damage caused by diseases is twofold: (1) Surveys to evaluate problems, and (2) research to develop control measures. Surveys determine the distribution and prevalence of disease--where it is found, where it is causing serious damage, when and where it is intensifying, and when and how control is feasible. Research is aimed at getting the facts regarding the biology of the causal organisms and the interrelationships of host, disease, and environment. These are prerequisite to the development of control measures.

For most forest diseases, basic knowledge is inadequate and a greatly intensified research program is necessary if progress is to be made in the future in reducing annual disease losses. Present staff and laboratory facilities in the Lake States are all too small in relation to the importance of the disease problem.

The Station, with a staff of three, is working on three major projects--Hypoxylon canker, oak wilt, and blister rust--plus giving occasional attention to other disease problems. In addition,



cooperative projects involving some financing by the Station are under way at the University of Minnesota, University of Wisconsin, Michigan State University, University of Michigan, and Michigan College of Mining and Technology. The Station is cooperating, too, with the Institute of Paper Chemistry on the disease aspects of their poplar breeding program. Activities on Station projects in 1955 are summarized briefly in the following paragraphs.

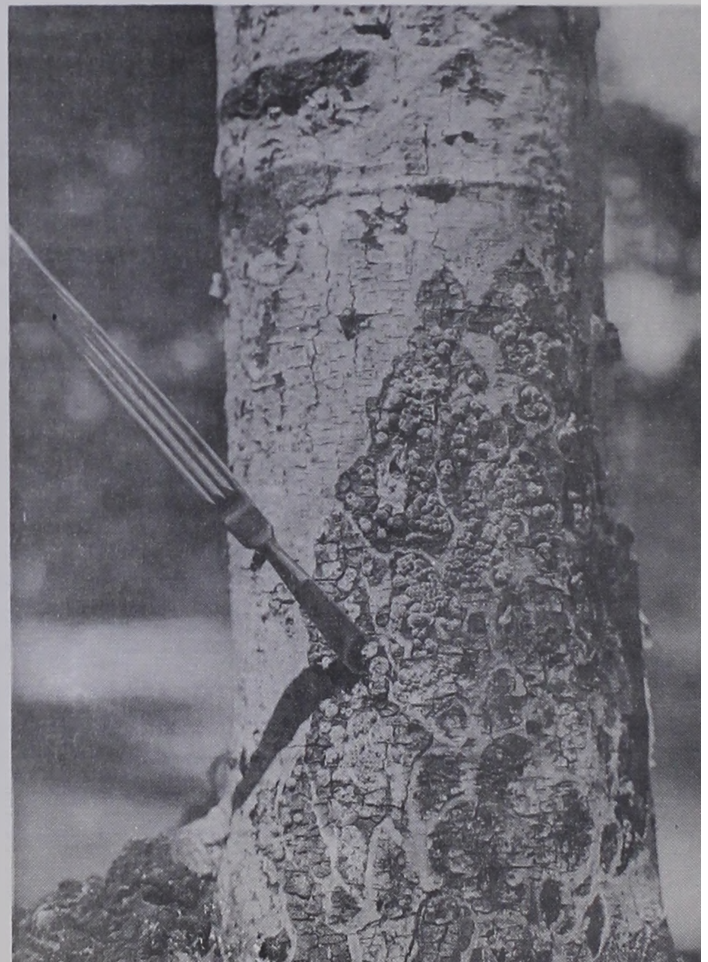
#### Hypoxyton Canker Study Continued

Most of the effort on this problem has been directed towards evaluation of the relationships between various stand and site characteristics and damage caused by the disease. In this phase of the problem the pulp and paper industry has made a major contribution by active participation in the studies and general cooperation. The Iron Range Resources and Rehabilitation Commission and the University of Minnesota have also made major contributions. Currently, most of the work involves maintenance, remeasurement, and evaluation of results from permanent plots and thinning studies established in previous years. Results as yet are incomplete and very tentative.

Available evidence indicates that the canker growth pattern varies appreciably from tree to tree and stand to stand. Since this pattern is directly related to the rate at which infections kill trees, it may have as important a bearing on actual damage caused in a stand as does the population of cankers. This possibility merits more intensive study.

As the Hypoxyton study has progressed, it has become increasingly clear that much of the difficulty encountered in solving the problem is due to insufficient knowledge on many phases of the biology of the causal fungus. Especially important is further knowledge on the conditions requisite to successful establishment in the tree. In 1955 a cooperative study was initiated with the University of Minnesota to investigate the mode of infection.

This Hypoxyton canker has numerous fruit bodies which produce the spores of the fungus.





Previous studies by the Station proved unsuccessful in inducing infection with spores of the fungus. Spores are the most logical means by which the fungus is presumed to spread in nature.

#### Influence of Microclimate on White Pine Blister Rust Infection

A new project on white pine blister rust was initiated in 1955 in cooperation with the University of Wisconsin. Previous work conducted by the University established that there is a strong correlation between topographic features, stand characteristics, and the prevalence of blister rust on white pine. The indications are that under certain localized conditions the microclimate is unfavorable for infection, and it is unnecessary to eradicate Ribes. At present microclimate appears to be a limiting factor primarily in the southern part of the region (southeastern Minnesota, southern Wisconsin, and the Lower Peninsula of Michigan). The purpose of the new study is to describe more clearly low- and high-risk sites as an aid to blister rust control.

#### Further Evidence on Races of White Pine Blister Rust

The possibility that the white pine blister rust fungus may consist of a number of races, or varieties, that vary in their ability to infect pines has an important bearing on developing pines that are resistant to the disease. For this reason a study was initiated 5 years ago in cooperation with the University of Minnesota to determine whether or not white pine blister rust is composed of races that vary in pathogenicity. To date, studies have been made only on the Ribes hosts. Last year evidence was found indicating that there is more than one race of the fungus. This year further studies confirmed this result. It is not known whether the races vary in ability to infect white pines.

During the year improvements were made in the greenhouse to facilitate the work. The unusually hot summer, however, prevented testing during the summer months; hence, the search for further evidence on races was very limited. Evergreen species of Ribes were tested and found to be useful for work during the winter season when other species are dormant.

#### Oak Wilt Rate-of-Spread Survey Initiated

The oak wilt damage survey was completed and results published in Station Paper 33 entitled "Oak Wilt Damage--A Survey in Central Wisconsin." A new survey was started to determine rate of spread of the disease--both local spread through root grafts and overland or long-distance spread. The primary objective is to determine the pattern of the two kinds of spread, that is, is it rather constant from year to year or does it fluctuate? This survey should provide information of value in estimating damage, and may also provide





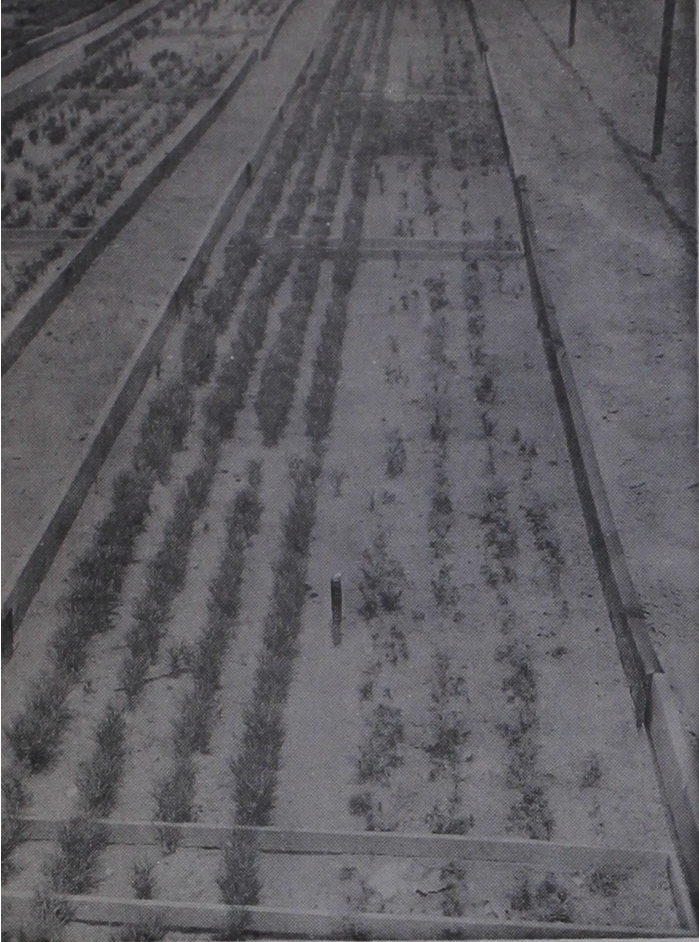
Evidences of races of white pine blister rust. The leaves are from a clone of Ribes hirtellum. Each was inoculated with rust spores, but from different collections. Note the difference in the spots resulting from infection. This is evidence of genetic variability in the rust.

some clue to factors influencing rate of spread and the potentialities of the disease. The first season's results indicated that overland spread occurred at about the same rate in all areas surveyed (central Wisconsin, southeastern Minnesota, and east-central Minnesota).

#### White Pine Root Rot Control Studies Give Promising Results

The white pine root rot problem at the Chittenden Nursery in Michigan has received considerable attention. Michigan State University and Chittenden Nursery personnel have cooperated with the Station in this study. A number of fungicides, insecticides, and soil fumigants have been tested in efforts to develop a control measure. The current season's studies have given promising results. The root rot has been controlled through the first growing season by treatment of the seedbeds with either 2 pounds of methyl bromide per hundred square feet or 1.5 ounces of 40-percent formaldehyde





White pine root rot at  
the Chittenden Nursery.  
No damage on red pine  
to left; severe damage  
on white pine to right.

per square foot. As yet, the cause of the disease has not been determined. The best possibilities appear to be fungi, nematodes, or both.

#### Hard Maple Defect Study Completed

Data from a study to determine the amount of decay and degrade caused by various types of old logging injuries on hard maple have been analyzed and prepared for publication. Results will be published in the near future. This study was conducted in cooperation with the University of Michigan and the Michigan College of Mining and Technology.

#### Other Research Needed

Current studies as listed above will require all the attention of the present staff. These studies should be stepped up, especially Hypoxylon canker of aspen. Other problems on which research is needed are as follows:

Heart rots and butt rots.--It is estimated that decay causes about 80 percent of the current disease loss. In this respect, heart rots and butt rots are more important than all other diseases combined. More and better information is needed on the relationship between site conditions and management practices on the one hand,



and the development of decay in many of our more important tree species on the other. Better methods of decay detection are also needed for many species.

Bacterial wetwood of aspen.--Wetwood is very common in aspen and is recognized as interfering with utilization of the infected wood. Essentially, nothing is known about its development in trees. Its distribution in trees and stands, its relationship to site factors, and the mode of infection should be determined.

Plantation diseases.--In addition to recognized problems in plantations, such as root rot and needle droop of red pine, there is need for general evaluation. The older plantations in the region are approaching the age at which difficulties can be anticipated on the basis of experience elsewhere.

General disease surveys.--The relative prevalence and impact of the various diseases should be studied more intensively as an aid in directing research and control efforts.

#### Plans for 1956

Efforts for the coming year will be concentrated mainly on Hypoxylon canker, oak wilt, and white pine blister rust. Present studies on all three diseases will be continued. As the analysis of accumulating data indicates other possible solutions to problems, new studies will be established.

The white pine root rot studies will also be continued with the objective of obtaining adequate and economical control of the disease over the 4-year period that stock is subject to damage in the nursery. Efforts will be made to determine the cause of the disease.

FOREST        Insects cause heavy damage to the Nation's forests in  
INSECTS       three ways: Through loss of growth and reduction of  
              timber quality in trees that survive the attacks and  
              through actually killing the trees. The Timber Resource Review  
showed that in 1952 the net loss in the Lake States region due to  
insects was 170 million cubic-feet in all growing stock and 694  
million board-feet of sawtimber. Loss of growth and reduction in  
timber quality on living trees were by far the most important  
effects; relatively little mortality was reported. In coming years  
mortality may become more of a problem; severe insect attacks some-  
times kill thousands of acres of trees.

Two factors made possible an augmented forest insect research program at the Station this year: In late 1954 and early 1955 three entomologists were added to the Forest Insects Division. And in



the early spring a forest insect laboratory was established on the Kawishiwi Experimental Forest near Ely, Minnesota, thus facilitating insect studies in northern Minnesota.

Major research projects in the region included studies on the biology and ecology of the spruce budworm, laboratory tests of the effectiveness of the newer insecticides against the larch sawfly as well as studies on growth reduction in the heavily infested tamarack types in Minnesota, and the development of more accurate techniques for predicting Saratoga spittlebug damage.

The major part of the insect survey effort was devoted to Saratoga spittlebug infestations on Wisconsin and Michigan National Forests, larch sawfly aerial surveys and spruce budworm aerial and ground surveys in northern Minnesota. Minor surveys covering the red pine sawfly and the pine tortoise scale in Michigan, the walkingstick in Wisconsin, the pine leaf aphid in Minnesota, and the jack-pine budworm in Minnesota and Wisconsin were also made.

Insects in plantations are annually becoming a more serious problem, but research in this field is still on a too limited scale. The

Spruce budworm research: collecting branch samples for use in life history studies.

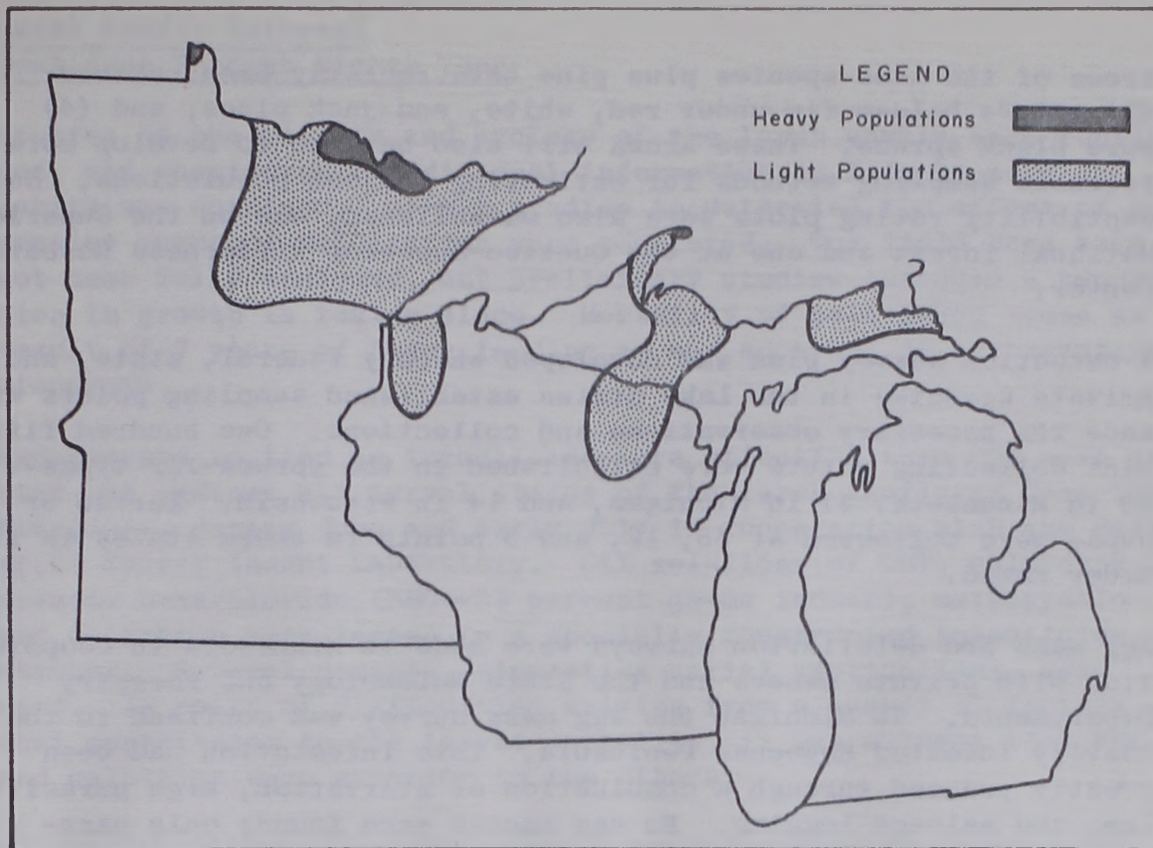
more important species are the Saratoga spittlebug, the pine sawflies, the European pine shoot moth, the white-pine weevil, and the pine chafer. All of these insects are commonly found in Lower Michigan where the plantation acreage is the largest in the Lake States.

#### Spruce Budworm Populations Are Increasing

A broad research program covering the biology and ecology of the spruce budworm was developed and field work begun this year in the spruce-fir types in northern Minnesota. The main objectives, pointed toward prevention of serious damage in this region are: (1) To study the insect's life history and habits, and determine how they may differ from those in other regions where the forest conditions are different; (2) to determine the potential value of the various natural control factors and means for increasing their effectiveness; and (3) to







The spruce budworm was found over a larger area  
in the Lake States than in 1954.

study the susceptibility of balsam fir in the several forest types where it is an important stand component, and to develop measures for reducing this susceptibility.

As a part of the study of natural control factors, 15 species of parasites were reared and their identity determined in 1955. The most abundant was the pupal parasite, Apechthis ontario (Cress.). Four larval parasites were also relatively common, but egg parasites were present only in small numbers. Meteorus trachynotus Vier. and Lypha setifacies West., which are indicator parasites in the Northeast (their abundance indicates trends in budworm populations), were present in small numbers. It is still too early to make predictions concerning the effectiveness of these natural control factors and the importance of possible indicator species.

Permanent project areas to study natural control factors and the relationship between budworm population levels and degree of defoliation were established in Minnesota in the following stand conditions: (1) Uncut stands of mature aspen and white spruce with an understory of mature balsam fir; (2) a mixed stand of young balsam fir, white and black spruces, and aspen from which overtopping



trees of the same species plus pine have recently been removed; (3) mature balsam fir under red, white, and jack pines; and (4) pure black spruce. These areas will also be used to develop more reliable sampling methods for estimating budworm populations. Susceptibility rating plots were also established, one on the Superior National Forest and one at the Quetico-Superior Wilderness Research Center.

A detection survey plan was developed whereby federal, state, and private agencies in the Lake States established sampling points and made the necessary observations and collections. One hundred fifty-nine collecting points were established in the spruce-fir types-- 88 in Minnesota, 57 in Michigan, and 14 in Wisconsin. Larvae or pupae were collected at 58, 12, and 5 points in these states in the order named.

Egg mass and defoliation surveys were made in Minnesota in cooperation with private owners and the State Entomology and Forestry Departments. In Michigan the egg mass survey was confined to the heavily infested Keweenaw Peninsula. This infestation had been greatly reduced through a combination of starvation, high parasitism, and salvage logging. No egg masses were found; only parasitized pupae were collected. Defoliation surveys, aerial as well as ground, showed scattered areas of noticeable defoliation in Minnesota near the Canadian border. However, the infestation, generally speaking, is still very light, and direct control in 1956 will not be necessary.

#### Jack-Pine Budworm Widespread in the Lake States

Dissections of pupae of the jack-pine budworm, collected in declining infestations in Upper Michigan, showed that the degree of parasitism had materially increased over that reported in 1954. Parasitism in heavily infested stands in Minnesota was already at a relatively high level; at least 10 percent of the overwintering larvae and 31 percent of the pupae were parasitized. Itoplectis conquisitor (Say) was the most important species.

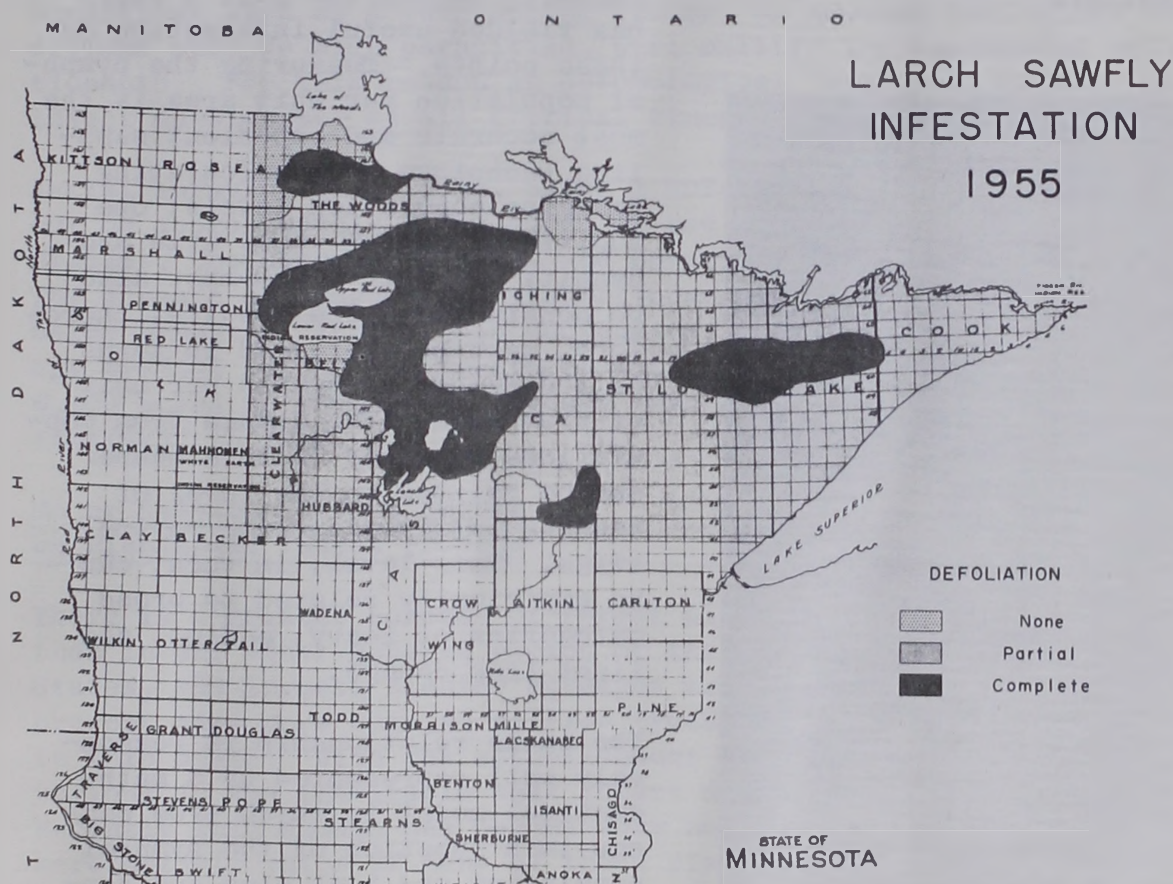
The infestations in the eastern part of Upper Michigan declined in severity, the heaviest feeding now being centered in low-value orchard-type trees. The Lower Michigan infestations continued at endemic levels. In Minnesota the acreage of heavy infestation increased very sharply. More than 70,000 acres in Crow Wing, Hubbard, and Beltrami Counties were heavily infested, and a much larger adjacent acreage suffered light to moderate feeding. Cutting operations to remove the susceptible trees were carried out to a limited extent in Beltrami County. Moderate to heavy feeding was reported on more than 100,000 acres in northern Wisconsin.



## Larch Sawfly Outbreak Continues Through Eighth Year

Studies of the biology and ecology of the larch sawfly were continued, and considerable additional information on life history and habits was obtained. Growth studies to determine the effect of successive years of defoliation were completed. The field data have not been fully analyzed, but preliminary studies indicate a reduction in growth is taking place. Mortality of pole-sized trees as a result of 7 years of heavy feeding is now apparent in northeastern Minnesota.

Experiments to find an insecticide more effective than DDT were carried out against all larval stages of the larch sawfly at Cass Lake, Minnesota, during June and early July in cooperation with the Beltsville Forest Insect Laboratory. Oil solutions of DDT, chlordane, benzene hexachloride (BHC--36 percent gamma isomer), methoxychlor, and malathion were tested in a specially constructed insecticide chamber. Several dosages, simulating aerial applications, were used. In spite of difficulties arising from a number of factors that contributed to the larval mortality, it was evident that BHC and malathion were superior to the others.



The acreage of complete defoliation by the larch sawfly increased greatly in 1955.



The annual aerial survey of the infested tamarack stands in Minnesota was made in 1955 under the direction of the State Entomologist with technical advice and assistance from Station personnel. There was a much larger area of complete defoliation than in 1954; 78 percent of the tamarack type suffered partial to complete defoliation. An area of general infestation now exists in northern Wisconsin and Michigan, moderate to heavy feeding being noticeable in widely scattered stands.

#### Saratoga Spittlebug Research Improves Survey Techniques

Chemical control of Saratoga spittlebug infestations in red pine plantations constitutes a large annual expenditure in the Lake States. On national-forest land in Wisconsin and Michigan from 4,000 to 10,000 acres of plantations are sprayed annually to prevent excessive tree mortality and loss in value due to poor growth and form. To insure that the chemical control program is carried

out on sound biological and economic bases, an accurate sampling technique must be devised to determine population levels and their damage potentials.

Caging spittlebug adults to determine frequency of feeding and host damage potential.

Research during the past 3 years has yielded useful information on these points. Measuring the nymphal population per unit area is the most accurate and expedient sampling technique. In calculating damaging population levels, one additional factor--host size and density per unit area--must also be considered. The results, therefore, must be expressed in terms of the number of nymphs per unit of tree size. The damage from populations measured in this manner can be related to the level of feeding injury occurring on the twigs. This level, in turn, can be empirically related to broad categories of heavy, medium, and light tree damage.

The whole relationship is reasonably well represented by a mathematical model in which tree damage is a function of the nymphal population and host size and density. Data from permanent research





plots indicate a reasonably well-defined straight line relationship of the following type:

$$X = a + b \frac{A}{B}$$

X = tree damage (feeding punctures per 10 cm. of 2-year-old twig).

A = nymphal population per 1/10 milacre.

B = tree size and density factor (average height x average whorls x number of stems per acre).

a & b = dimensionless constants which, on the basis of this year's data, are:

$$a = 0$$

$$b = 17$$

The levels of "X" have been empirically classified as follows:

0 through 10 feeding punctures per 10 cm.--light infestation.

11 through 29 feeding punctures per 10 cm.--moderate infestation.

30+ feeding punctures per 10 cm.--heavy infestation.

This mathematical model will allow the prediction of tree damage in terms of feeding puncture density when given only the spring nymphal population and the tree size and density. Extreme weather conditions such as a late spring freeze, or adverse biological conditions such as high parasitism, will nullify the calculated relationship. For this reason an entomological "eye" must be kept on insect development at all critical times.

Aerial spraying operations, using a DDT-oil solution, were carried out on approximately 9,300 acres of red pine plantations on the Nicolet, Chequamegon, Ottawa, and Upper Michigan National Forests. The acreage of susceptible plantations--height and density of stand being important factors--is decreasing, and in the future the acreage needing survey and treatment will be smaller. Approximately 6,400 acres on these four Forests have been designated for probable treatment in 1956.

#### Major Research Effort Needed on Plantation Insect Problem

There is a greater acreage of forest plantations in the Lake States than in any other general region of the country. Of the three States, the largest planted acreages are in Michigan, and at the present time more than 40 million trees are being planted annually in this State. With the establishment of large acreages of plantations it was inevitable that insect damage would be a problem. Recently this damage has become very noticeable, and the potential merchantable value of many of these plantations is threatened.





Successful plantations will be an important factor in the future forests of this country--a heritage that cannot be treated lightly. The situation in Lower Michigan is especially critical, the white pine weevil and the European pine shoot moth being the most important pests. The latter has developed to epidemic status in recent years, and many plantations have been heavily damaged. Four mild winters and favorable hibernating conditions have resulted in a very marked increase in severity of attack as well as infestation of new areas this past year. Christmas tree growers consider the European pine shoot moth their most serious problem, for trees damaged by this insect will be of poor form and little value.

The increasing importance of plantations in the economy of the Lake States calls for a thoroughgoing study of the insect problem. Such a study has been requested by plantation owners, and a preliminary plan has been developed. At the beginning it is proposed



that major emphasis will be placed on insecticidal tests against the European pine shoot moth, as this insect is recognized as one of the most important adverse factors affecting the Christmas tree industry. Studies of the relation of low temperatures to degree of infestation will be continued.

#### Miscellaneous--

#### Surveys and Control

Working in collaboration with the forest insect survey agencies in the Lake States and the teaching staffs at the universities, Lake States entomologists are developing uniform survey procedures for the important forest insects in the region. Six of these survey methods, covering the spruce budworm, the jack-pine budworm, the larch sawfly, the pine sawflies, the forest tent caterpillar, and the pine tortoise scale have been undergoing field trials this year. Techniques for additional species, such as the Saratoga spittlebug, the European pine shoot moth, and the white-pine weevil will be tried out next year.

Approximately 1,000 acres of high-value oak woodland on the Menominee Indian Reservation were aerially treated with a DDT-oil solution to control the walkingstick; a very high degree of control was obtained. This treatment will prevent reinfestation for several years, as the insect is wingless and movement into new areas is very slow.

An extensive and heavy pine leaf aphid infestation in planted and natural white pine in northeastern Minnesota was virtually eliminated in May by natural factors which killed the nymphs developing in terminal galls on the alternate host--black spruce. Experimental spray operations in cooperation with the Quetico-Superior Wilderness Research Center were cancelled because of the lack of infestation.

#### Plans

#### for 1956

Biological, ecological, and control studies will again be concentrated chiefly on the spruce budworm, larch sawfly, and the Saratoga spittlebug. A progress report will probably be issued on the 4 years of work on the larch sawfly. In addition, outlines will be prepared for departmental bulletins, summarizing present knowledge on the larch sawfly and the Saratoga spittlebug. As mentioned above, a start will be made on the plantation insect problem by emphasizing control studies on the European pine shoot moth.

An aerial survey, on a larger scale than that carried out in 1955, will be made to determine the extent of noticeable defoliation by the spruce budworm. Other surveys will include an egg mass survey for the spruce budworm, an appraisal survey on national-forest



stands infested by the jack-pine budworm to determine whether control measures will be needed, and a survey on tamarack mortality caused by the larch sawfly. Advice and assistance on surveys by other forest insect survey agencies will be given as needed.

FOREST            By cooperative agreement with the Fish and Wildlife  
WILDLIFE        Service, U. S. Department of Interior, the Station has  
                 a biologist assigned to it by the Section of Wildlife  
Investigations on Public Lands, Branch of Wildlife Research. He  
conducts studies concerning the effects of wildlife on the forests  
and the control of populations. Other public agencies and the  
Quetico-Superior Wilderness Research Center cooperate on many of  
the studies.

A few of the findings during 1955 on three of the current projects  
are discussed below.

#### Herbicides Stimulate Regrowth of Mountain Maple Deer Browse

On the Superior National Forest clumps of mountain maple, now grown  
out of reach of deer, were top-killed to make more browse available.  
Two kinds of herbicides, the butoxy ethanol esters of 2,4-D and  
2,4,5-T were used at concentrations of 4, 8, 12, and 16 pounds AHG  
(acid equivalent in 100 gallons of diesel oil). Diesel oil alone,  
cutting with an axe, and scorching by a propane torch and a flame  
thrower were also tested.

Preliminary results are as follows:

1. 2,4-D is superior to all methods except axe-cutting, under the  
conditions of the trial.
2. Cutting down the out-of-reach stems resulted in greater re-  
growth than did any of the fall herbicide treatments at 4 and  
8 pounds AHG.
3. Breast height applications of both herbicides resulted in sig-  
nificantly greater regrowth than did applications at the base.
4. Within the range of 4 to 12 pounds AHG, the higher concentra-  
tions at breast height gave significantly greater regrowth than  
did the lower concentrations. Tests of significance for only  
those concentrations between 8 to 16 pounds indicated no dif-  
ference in regrowth.
5. Applications of 2,4-D made during the early bud swelling stage  
appear to be somewhat more effective than similar applications  
made in the early fall dormant stage.





Cutting mountain maple out of reach of deer results in the production of much deer browse. Picture shows regrowth in late August after three growing seasons.

6. Observations of the extent of browsing on regrowth indicate no aversion to the treated clumps as compared with the controls.

#### Snowshoe Hares Damage Planted Jack Pine

In 1949 an exclosure was established on the Superior National Forest in a jack pine plantation that had been planted with 2-0 stock in 1948 and replanted with similar stock in 1949. Half of the exclosure was deer-proof and half both deer- and hare-proof. In 1950, and again in 1951 and 1955, all trees in the exclosure and in a comparable unprotected plot were measured for height.

The 1955 results show no mortality in the deer- and hare-proof part, 4.5 percent in the deer-proof part, and 10.4 percent on the unprotected plot. Although the mortality was light for the trees accessible to hares, considerable damage resulted from loss in height. On the unfenced plot the trees ranged from 1.4 to 9 feet in height and averaged 4.6 feet; 49 percent of them were less than 5 feet tall. In the section of the exclosure that was deer-proofed only, the trees ranged from 2.5 to 7.8 feet tall and averaged 5.3 feet; 38 percent of them were less than 5 feet tall. In contrast, the trees in the deer- and hare-proof section ranged from 5.4 to 12 feet in height, averaged 9.2 feet, and all were taller than 5 feet.



### Severe Deer Browsing May Stimulate Mountain Maple Regrowth

In the fall of 1952 a study was started on the Superior National Forest to discover the amount of browsing that mountain maple can withstand and still recover satisfactorily. Fifty clumps were selected at random and measured each fall to determine annual growth and each spring to determine consumption by deer.

A statistical analysis has been made of the data for 2 years: From the fall of 1952 to the fall of 1953, and from the fall of 1953 to the fall of 1954. Although deer browsed about half of the annual growth in the winter of 1952-53, the removal had no effect on the regrowth that followed. During the winter of 1953-54 the deer browsed 88 percent of the annual growth; this severe deer browsing stimulated regrowth so that by the fall of 1954 the plants had 17 percent more browse than in the previous fall. Rainfall was greater in the summer of 1954 than in 1953. Apparently regrowth is influenced by the amount of deer browsing and by the amount of rainfall during the growing season.

### Other Research Projects

Other research projects in 1955 included studies on: (1) The effects of birds and mammals on the establishment of tree seedlings and other woody plants following fire in a mixed conifer type, (2) silvicultural practices in mixed coniferous swamps in relation to the establishment of tree reproduction and shrubs of value to deer and other wildlife, and (3) the effects of mammals on yellow birch seedlings.

### Plans for 1956

Work will be done on all of the projects discussed above. The study of the effect of deer and hares on woody vegetation will also include a re-tally of the vegetation in exclosures on the Tamarac Refuge and the Chippewa National Forest. To be published soon are summaries of the results of special deer hunts on the Mud Lake Refuge, and the use of herbicides in inducing regrowth of mountain maple for deer browse.

FOREST FIRE RESEARCH	The Timber Resource Review revealed that the forest fire situation in the Lake States is not serious. Fire losses are low, and nearly 100 percent of the forest land is under some sort of protection. Fire research has contributed much to the methods and efficiency of fire control agencies responsible for this good record.
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In the summer of 1955 the Station filled the staff position resulting from the retirement of J. A. Mitchell. The early assignments of this man were designed to acquaint him with the fire problems of this region. His first research project will be a study of fuel factors in young pine plantations. These plantations, because of their high economic value and unbroken canopy, offer unique problems in fire control.

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## F O R E S T     M A N A G E M E N T

In the opening paragraphs of this report some of the significant findings of the Timber Resource Review in the Lake States were outlined and discussed. From the figures on timber resource and the estimated demand for forest products in the years 1975 and 2000, it is evident that intensive management of Lake States forests will be needed in the years ahead. Considerable progress has been made as shown by the resource inventory, but much yet remains to be done to improve the quality of timber produced, to increase the proportion of species with desirable qualities, and to return brushy and poorly stocked areas to production. Research at this Station is aimed at these problems. In the following pages some of the implications of TRR findings will be mentioned in connection with the forest management studies from which new information is available.

The Station's annual report for 1954 told of the initiation of a substantial forest genetics program and the start of integrated forest management-utilization research. During the past year specialists have been added to the staff to keep these activities moving ahead. Necessary preliminaries to initiation of a well-balanced program in new fields of research are: Acquainting new personnel with work areas and their problems, analyzing research needs, assembling research equipment, and locating areas for field installations. Much of this preliminary work has been accomplished, and several research projects are now under way in tree improvement and management-utilization. Considerable assistance has been received from cooperating organizations that had special talents, specific information, or suggestions for research problems.

Another development of the past year was an expansion of studies in soil-site relationships. Knowledge of the quantitative effects of soil characteristics, especially texture, depth, pH, and water-table levels, upon the growth rate of stands in the Lake States are important to the forest manager. Many of his decisions, ranging from choice of species to be planted to selection of age at which



to harvest, can be made more wisely if the fundamental capacity of the site for growth can be determined more exactly than it can be at present. To obtain such knowledge, soil-site studies have been started in white birch stands, mainly in northern Wisconsin, and in swamp black spruce and aspen in Minnesota.

Work on older projects requiring periodic measurement and analysis was continued. Several major publications, the culmination of many years' research, have been issued during the year or have been placed in the hands of the printer. Among those published were a report on composite volume tables and one on plantation release; comprehensive reports on nursery practice in the Lake States and plantation pruning in Michigan will be printed soon. Numerous minor publications have been issued giving the results of smaller studies or limited phases of larger projects. In addition to such published material, several regionwide and numerous local meetings were conducted to acquaint others with the Station's forest management program, to exchange research results, and to discuss fields for additional projects.

The following pages report the more significant activities in forest management research in the year 1955.

FOREST GENETICS      The Timber Resource Review points out that there is no surplus of forest land in this country. To meet future needs for wood products, the per-acre production must be increased. One means of accomplishing this is to improve the inherent quality of growing stock, thus establishing stands that grow more rapidly, are more resistant to disease and insects, and produce wood of improved technical qualities. Such improvement of the genetic quality of timber stands has both short- and long-term aspects. Past work on seed sources of species being planted in the region helps in selection of stock well suited to the planting site. Detailed descriptions of the characteristics of inherently superior trees are an aid to the timber marker in selecting trees to be left to provide seed or for additional growth. Deferred benefits can be expected from research on controlled breeding and hybridization. 1955 represents the first full calendar year of activity in the Station's forest tree improvement project. Although intermittent study on seed sources has been part of regular forest management activities since 1928, a specific project allowing expansion into other genetics work was not set up until July 1954.

#### Study of White Spruce Begun

During 1954 the pulp industry of the Lake States consumed more than 3,000,000 cords of wood, of which nearly 900,000 cords were spruce. More than half of the spruce was imported from Canada. Because of





To the left are 2 adjacent red pines, 1 of fair form and 1 of poor form. To the right are red pines of excellent form. How much these differences reflect heredity and how much environment cannot be inferred from appearances alone. Only tests of the progeny of these trees can tell the story. In the meantime, trees like those at the right are recommended as sources of seed for planting. Tests may, however, show that either or both trees at the left may also be suitable sources of seed.

the certain continued demand for large volumes of spruce wood by the industry, and because of the opportunities for improving this species due to its numerous local races, first emphasis in the Station's tree improvement program has been given to white spruce.

Some white spruce seed has been obtained and additional collections will be made throughout the entire range of the species on this continent to study racial variation. Studies have also been initiated to determine the feasibility of propagating white spruce from cuttings taken in late summer and fall, and to develop suitable fall-grafting methods for white spruce, black spruce, and Norway spruce.



The effects of low temperatures and length of day have been incorporated in these studies. Also under way are studies of the viability of coniferous pollen.

#### Interregional White Pine Seed Source Study Planned

The Station participated with the Southeastern, Northeastern, and Central States Stations and the Ontario Department of Lands and Forests in planning a study of variation in eastern white pine. Each agency has agreed to collect white pine cones from specific localities within its region in sufficient quantity to furnish a supply to the others. White pine cones in the Lake States matured about 2 weeks earlier than usual in 1955, so collections were missed in Upper and Lower Michigan. The Station did make collections in northern Minnesota and northwestern Wisconsin and, for more limited use, in the St. Croix River Valley of Minnesota. Planting stock from all these seed collections will be grown in each of the participating regions.

#### Genetics Field Center to Be at Rhinelander, Wisconsin

Following a 1954 survey for possible locations in the Lake States, a site for a forest genetics field center was selected adjoining the Hugo Sauer State Nursery near Rhinelander, Wisconsin. Facilities are being provided here for all phases of tree improvement research. The site is close to nursery and progeny test areas made available by cooperators, and is conveniently near stands of the tree species to be studied first.

#### Forest Tree Improvement Conference Reports on Research

As a member of the Lake States Forest Tree Improvement Committee, the Station took part in the Second Lake States Forest Tree Improvement Conference held at Wisconsin Rapids, Wisconsin, on August 30-31. This conference was attended by 70 foresters, geneticists, pathologists, and entomologists from nine states and Canada, representing forest industries, educational institutions, and state and federal agencies engaged in or interested in forest tree improvement. The conference included brief reports of recent progress in forest genetics in the Lake States, the Northwest, the South, the Northeast, and Canada; a panel on techniques related to research in forest tree improvement; a field trip to forest tree improvement projects in the vicinity of Wisconsin Rapids; and reports of subcommittees on seed collection zones, tree and stand selection, and bibliography. The proceedings of the conference have been assembled and are being published by the Station.



## Progeny Test Sites Selected

The genetic worth of any tree or stand cannot be assessed until its progeny have been tested and compared with those of other trees or stands. For this reason it is highly important to have available sites representing a variety of conditions on which to plant these progenies. With this in mind, the Station genetics staff, in cooperation with national-forest personnel, examined 120 sites on the 7 national forests of the Lake States. Some 90 of these sites were reasonably suitable. Out of this number, 35 areas have been reserved as progeny test sites on the basis of species suitability, soils, and climatic conditions. All the sites are quite level, open, uniform, accessible, and at least 5 acres in size.

NURSERY        During the past year the objective has been to get the  
RESEARCH       results of past research into use. A comprehensive publication on nursery practice in the Lake States--a joint effort of the Station and the Regional Office--is now undergoing final editing and should be in print in 1956.

During the 1930's and 1940's considerable research was done on the nursery phases of growing conifers for planting in the Great Plains. The often highly alkaline soils and low rainfall present unique problems to the nurseryman raising coniferous planting stock. Available information is being prepared for publication.

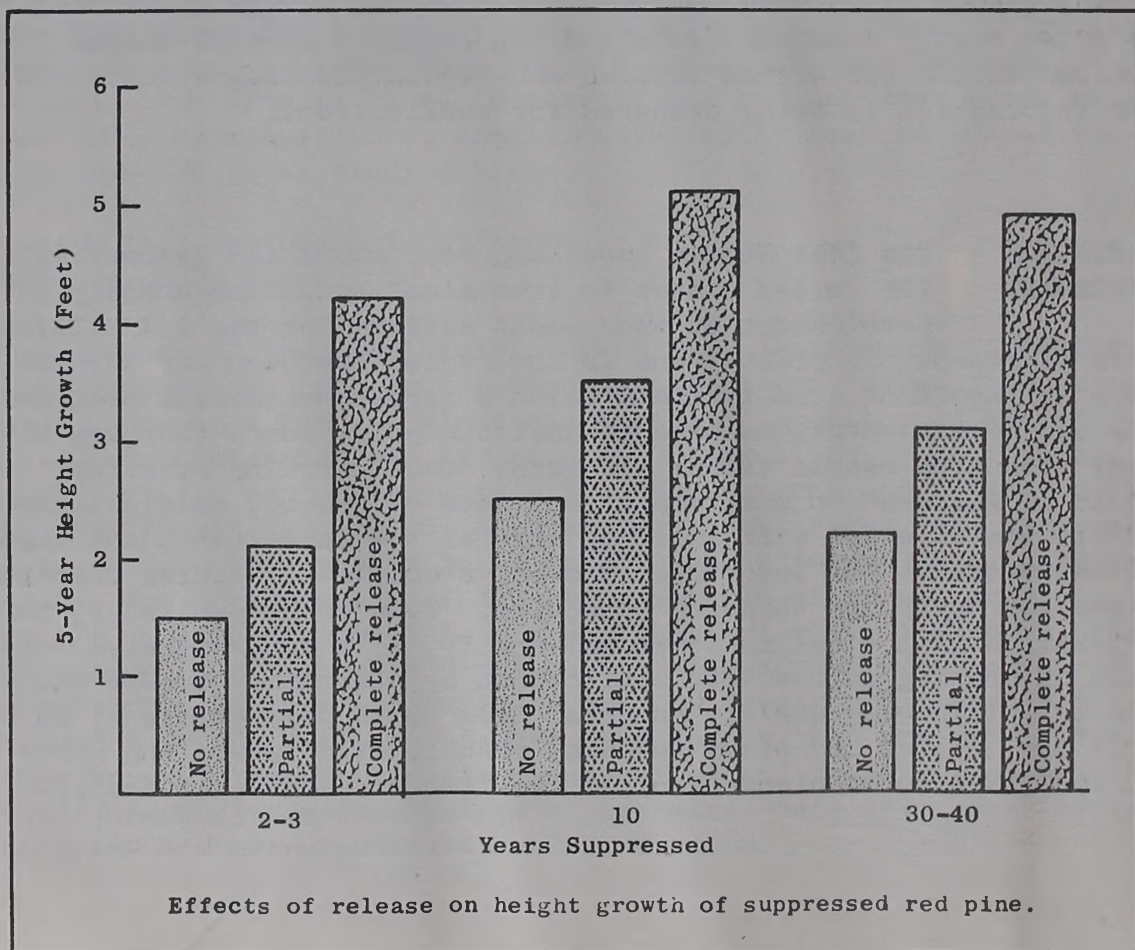
PLANTATION     The Lake States have long been among the leaders in  
MANAGEMENT     the United States in tree planting. Consequently, development of management methods for the 1.4 million acres of acceptable plantations in the region has been for several years an important item in the Station's forest management program. Many of these plantations have reached the point where they are already producing usable timber products. Good thinning practices should be followed to maintain a good rate of growth, obtain intermediate yields which will amortize some of the investment, and supply raw material for industry. Growing stock level studies furnish guides for desirable thinning schedules. Soon to be published, in cooperation with Michigan State University, is a comprehensive bulletin on pruning methods for application by plantation owners who wish to obtain high-quality material from their plantations at an early age. These and other research results will insure the maximum contribution of plantations to the timber resource of the region.



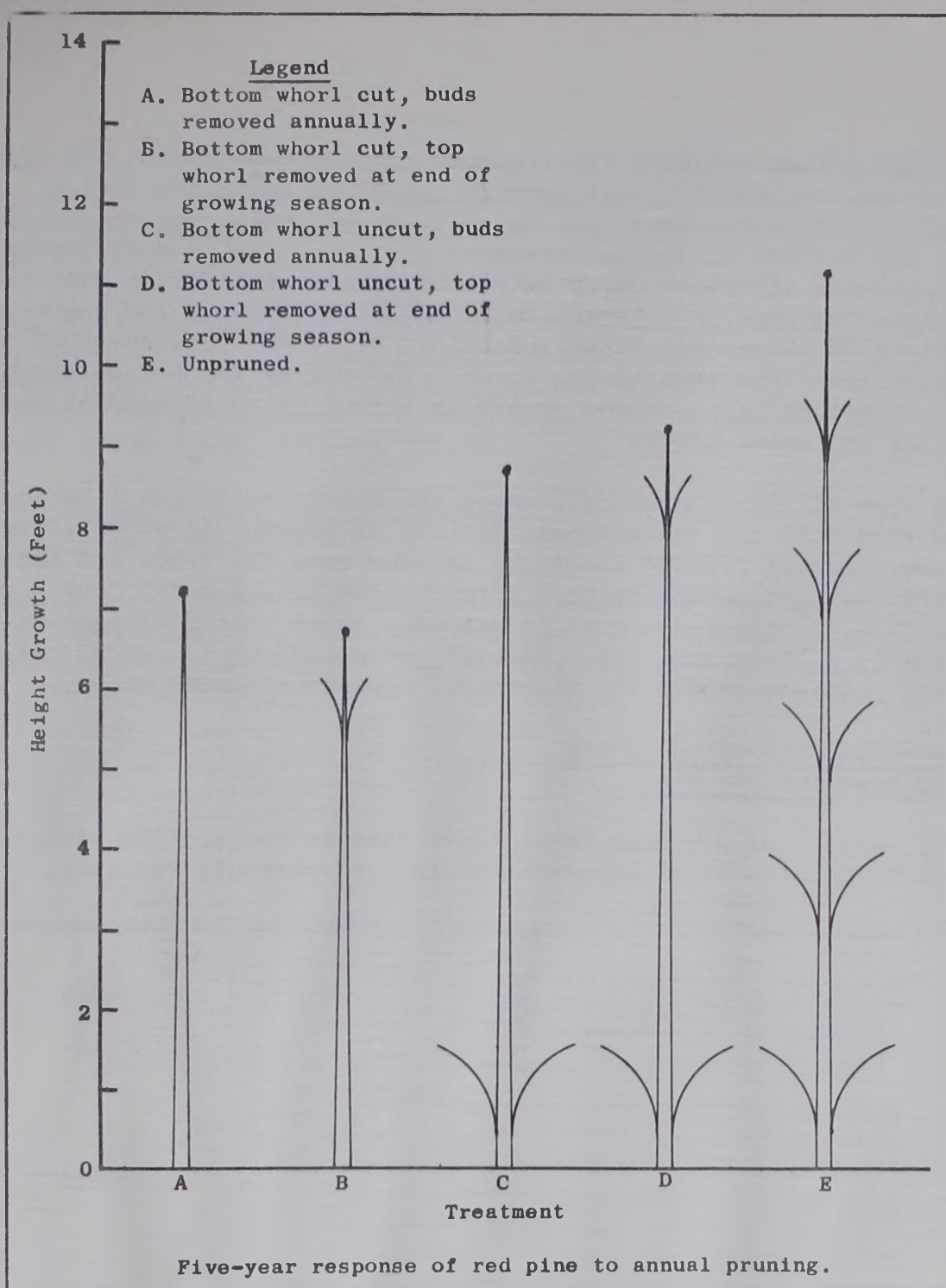
### Red Pine Makes Good Response to Release

Many red pine plantations are established under brush and tree cover which reduces their growth and may eventually cause mortality. With the development of less expensive chemical control methods, considerable acreages of overtopped plantations can now be released economically. The results of recent studies show that sufficient response to release is obtained to make such work attractive to the forest plantation owner.

In 1950 nine tests were installed in Lower Michigan on state and national-forest land in pine plantations that had been suppressed for periods of 3 to 40 years. The overstory oak, 30 to 65 years old, averaged about 60 square feet of basal area per acre. Complete release, maintained by eliminating sprout regrowth, partial release, leaving about 30 square feet of basal area, and no release were compared. Five years after treatment suppressed red pine of all ages tested had responded to release with greatly accelerated growth (see accompanying chart). The height growth of completely released trees in the period was double that of the unreleased pine, and diameter growth of the three oldest plantings five times that of the checks. The partially released trees grew at a rate midway between that of unreleased and completely released trees.







#### Annual Pruning of Red Pine Reduces Growth Rate

Annual pruning methods which remove branches or buds every year have caused a considerable reduction in both diameter and height growth as compared to that of unpruned trees. Five-year results of a study of annual pruning installed in cooperation with the Kent County, Michigan, Road Commission are now available. Four methods of pruning were used: (A) Bottom whorl cut and buds removed annually; (B) bottom whorl cut, uppermost whorl removed at the end of each growing season; (C) bottom whorl uncut, buds removed annually; (D) bottom whorl uncut, uppermost whorl removed at

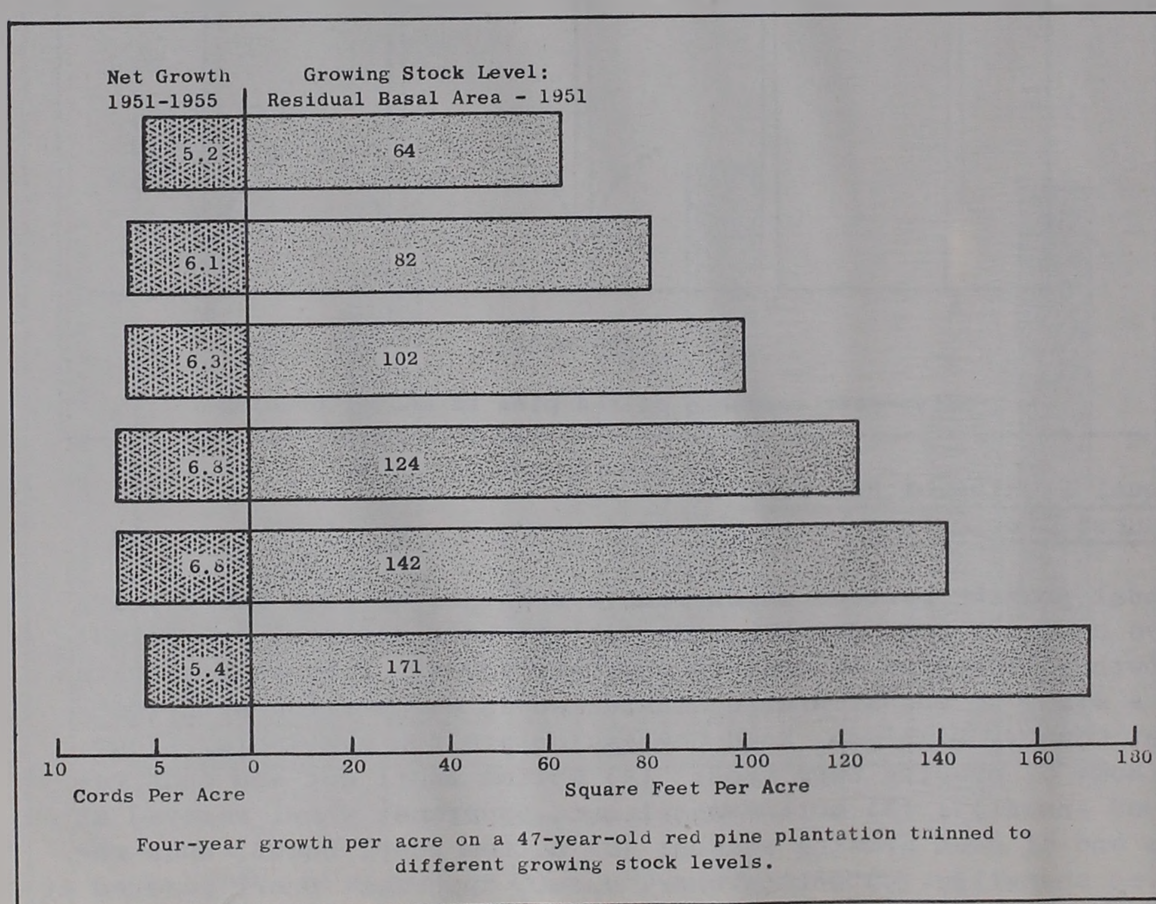


the end of each season's growth; and (E) unpruned check. The system of pruning showing most promise is (D) in which the bottom whorl and those uppermost on the stem which develop during the year, plus the needles on the main stem of the tree, are present during each growing season to carry on photosynthetic activities (see chart on preceding page). However, both treatments leaving the lower whorl uncut showed the least reductions of height growth--about 20 percent less than that of the check. Removal of the bottom whorl plus annual pruning reduced growth in height 35 to 40 percent below that of the check trees.

This type of annual pruning cleared the first log of the tree in less time than the conventional methods of pruning in several operations. Annual pruning should be started when the trees are about 5 feet tall and should be used only in plantations which grow 2 or more feet in height per year to permit a small number of operations to obtain a clear butt log. However, more testing is needed with annual prunings before its widespread use can be recommended.

#### Intermediate Stocking Levels Found Best for Red Pine

Early results of stocking level tests made in cooperation with the Michigan Department of Conservation in a 47-year-old red pine



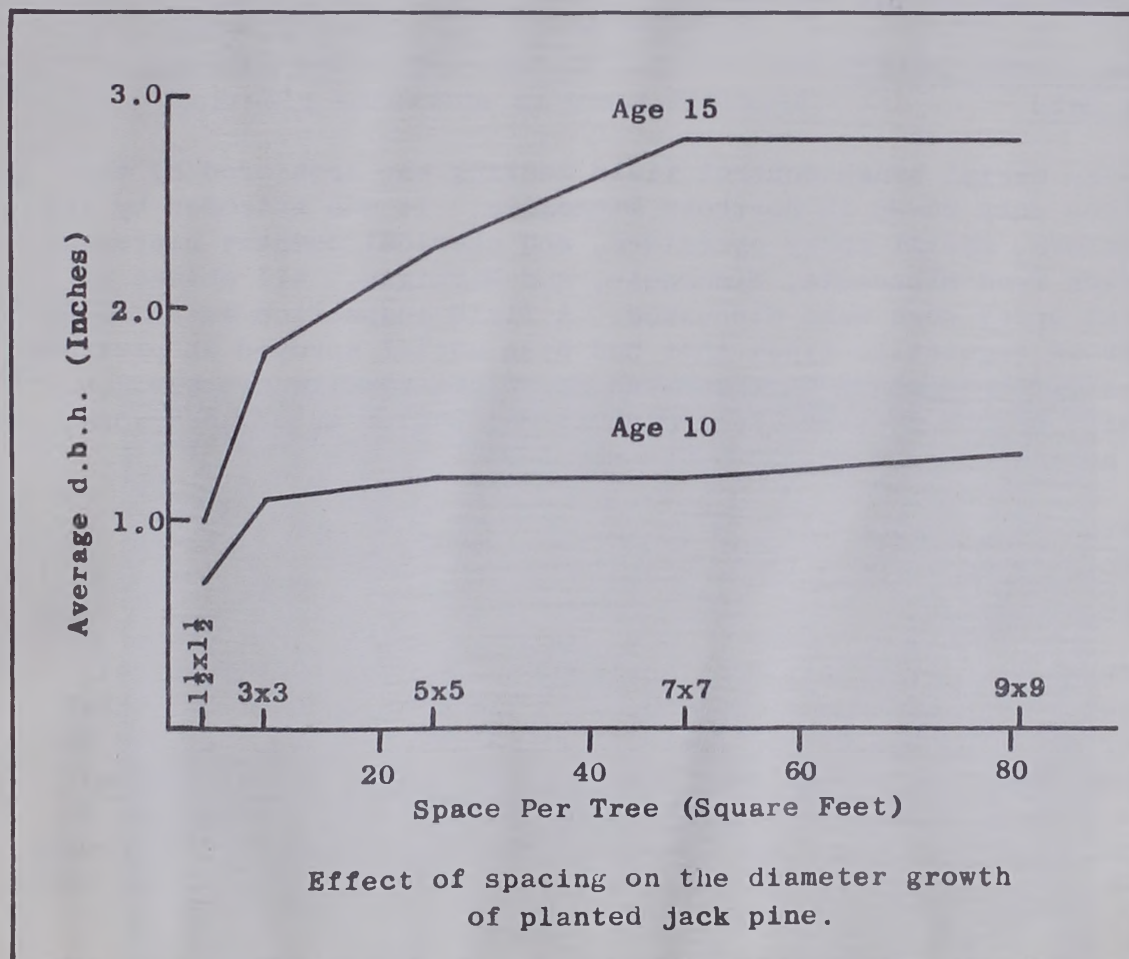


plantation in Lower Michigan indicate that stocking levels of from 80 to 140 square feet of basal area give about the same rate of cordwood growth. Stocking levels of 60 and 160 square feet were less productive.

Four years' growth on six compartments thinned to nominal levels of 60, 80, 100, 120, 140, and 160 square feet basal area per acre has averaged 3.5, 4.8, 5.0, 5.2, 5.8, and 4.8 square feet of basal area per acre per year. Cordwood growth, as seen in the accompanying graph, shows about the same trends.

#### Development of Jack Pine Plantations Affected by Spacing

A spacing experiment begun in 1941 in Lower Michigan demonstrates that diameter growth of densely planted jack pine is seriously retarded by dense planting, but that height growth of dominant trees is relatively unaffected.





The trees were planted at spacings of  $1\frac{1}{2} \times 1\frac{1}{2}$ , 3x3, 5x5, 7x7, and 9x9 feet. The two closest spacings gave considerable reduction in diameter growth; the three wider spacings gave about the same average diameters (see chart on preceding page). The dominant trees in the closer plantings are as tall as the trees in the plantations with wider spacing. Good growth is expected to continue in the 7x7-foot planting until the material is large enough for a commercial thinning. Plantations spaced 5x5 feet will need non-commercial thinning before a commercial operation is practicable. The 9x9-foot spacing is too open for the development of timber stands of satisfactory quality.

#### CHEMICAL HERBICIDES IN FOREST MANAGEMENT

Increased use of aerial sprays for controlling undesirable hardwood trees and brush for forest and game management purposes continued during 1955. Chemical herbicides that can be used to eliminate less valuable species in the forest without harming the desired ones are an important tool in checking the drift toward less desirable species reported in the Timber Resource Review survey of productivity of cutover lands. Herbicides are useful also for releasing coniferous plantations from brush and hardwood overstories, and preparing land for planting. During 1955 approximately 7,000 acres were sprayed from the air in the Lake States region for forestry and game management purposes.

#### Aerial Brush Control Tour Held

A 3-day aerial brush control field meeting was sponsored by the Station July 26-28 in northern Minnesota. It was attended by 100 foresters, aerial spray operators, and chemical company representatives from Minnesota, Wisconsin, and Michigan. All phases of aerial spray work were discussed. A field inspection was made of numerous vegetative types that had been aerial sprayed in previous years for release of conifers and for planting site preparation. A summary of the meeting, including formal papers and discussions, was published as Miscellaneous Report No. 39.

#### Control of Labrador Tea by Foliage Spraying with 2,4-D and 2,4,5-T

A fourth-year examination of small plots sprayed near Cohasset, Minnesota, in late October 1950, with the propylene glycol butyl ether ester of 2,4,5-T in fuel oil at rates of 7, 16, 31, and 65 pounds per acre, showed that Labrador tea (Ledum groenlandicum) made a 46-percent recovery after the lightest application, an 8-percent recovery after the 16-pound treatment, 13-percent recovery after the 31-pound application, but was completely killed out where



the heaviest application was made. Where fuel oil alone was used, recovery of the shrub was complete.

Recovery was also very high on plots where 2,4,5-T and 2,4-D were applied separately in water solution at rates of 5, 9, 18, and 38 pounds per acre approximately in mid-July of 1950. Where the two lighter applications of 2,4-D were made there are now more stems than before spraying.

Tests with Undiluted 2,4-D and 2,4,5-T  
in Frill Girdles for Control of Oak

The standard herbicide mixture used for frill girdle work in this region consists of 2,4,5-T ester diluted in diesel oil with 4 to 8 pounds acid equivalent per 100 gallons, applied at the rate of about 6 ml. per inch of diameter. Tests of more concentrated mixtures have been limited. Therefore, the use of undiluted amines and esters of 2,4-D and 2,4,5-T in frill girdles for the control of oak was tried in a study in Lower Michigan. Commercial preparations, 4 pounds acid equivalent per gallon of propylene glycol butyl ether ester of 2,4-D and 2,4,5-T, alkanolamine salts of 2,4-D, and triethyl amine salt of 2,4,5-T, were applied undiluted at the rate of  $\frac{1}{2}$ , 1, and 2 ml. per inch of diameter in 4 different types of cuts at 2 different seasons and on 2 species of oak.

Applying undiluted liquid herbicide to partially girdled scrub oak--one method for controlling undesirable hardwoods in Lower Michigan.





The 4 cut surfaces were: (1) Complete frill girdles  $1\frac{1}{2}$  inches deep, (2) complete frill girdles  $\frac{1}{2}$  inch deep, (3) partial frill girdles  $1\frac{1}{2}$  inches deep (alternate cuts 4 inches wide and 4 inches apart), and (4) partial frill girdles  $\frac{1}{2}$  inch deep.

The 4 herbicides, 3 volume rates, and 4 cut surfaces were applied to at least 5 trees each of red and white oaks ranging from 6 to 10 inches at breast height. The first treatment was installed in September 1954 and the second in April 1955.

In August 1955 nearly all trees completely girdled with deep frills and treated with the 4 undiluted herbicides, at volumes of  $\frac{1}{2}$ , 1, and 2 ml. per inch of diameter, had dead tops. The amine of 2,4-D was consistently more effective than the other herbicides, especially at the low volume rates on trees with shallow and partial girdles. Since the minimum volume of 2,4-D amine approaches the costs of the standard mixture of 2,4,5-T ester in diesel oil, further comparative tests are planned.

#### Costs of Chemical Debarking of Scrub Oak for Pulpwood

As the first step in initiating a study of forest management possibilities in the scrub oak lands of Lower Michigan, 10 acres of northern pin oak and white oak were chemically treated with sodium arsenite in the first week of June 1955 to debark the oak for pulpwood. All of the peel-girdled, chemically treated trees were top-killed within a few days. About half of the trees had produced weak sprouts by the end of the first growing season.

Costs for treating 103.5 rough cords were as follows:

	<u>Cost per cord</u>
1 man applying chemical for 28.86 hours at \$1.65 per hour	\$ 0.46
3 axemen girdling for 86.57 hours at \$1.30 per hour	1.09
9 gallons sodium arsenite at \$2.11 per gallon	<u>.18</u>
Total cost	\$ 1.73

After adjusting for differing labor rates and tree volumes, these costs are comparable to those obtained elsewhere for treating conifers and aspen. While species bark characteristics have some effect, costs per cord depend primarily on the merchantable height-diameter ratio of the trees treated. The time and chemical needed to treat a cord of scrub oak would treat nearly  $1\frac{1}{2}$  cords of aspen.



Simulated Aerial Spray  
Method Developed

To determine the optimum amount of herbicide and herbicide solution needed to kill brush of different species and densities, the Station, in cooperation with the Minnesota Office of Iron Range Resources and Rehabilitation, has built a portable cage, enclosing 1/1000 acre, in which the low volumes characteristic of aerial spraying will be applied. Preliminary trials show this device to work satisfactorily under field conditions, clearing the way for intensive tests simulating aerial spraying.



Portable cage for simulating aerial spraying.

NATURAL PINE      Projected demands for timber in the next half century call for a considerable increase of both growth and inventory of softwood timber in the eastern portion of the country if the demands of the economy are to be met. In the face of this great need, we have the disturbing fact that softwood volumes in the Lake States, measured either in cubic volume or board-foot volume, have decreased by 20 percent and 30 percent respectively between 1936 and 1953. Approximately half of the softwood volume in the region is contained in pine stands. Thus, the management methods used in these stands will have considerable importance both locally and nationally in the years to come. Long-term studies established in natural pine stands by the Station in the past 20 years continue to contribute much needed information on the management of these species.

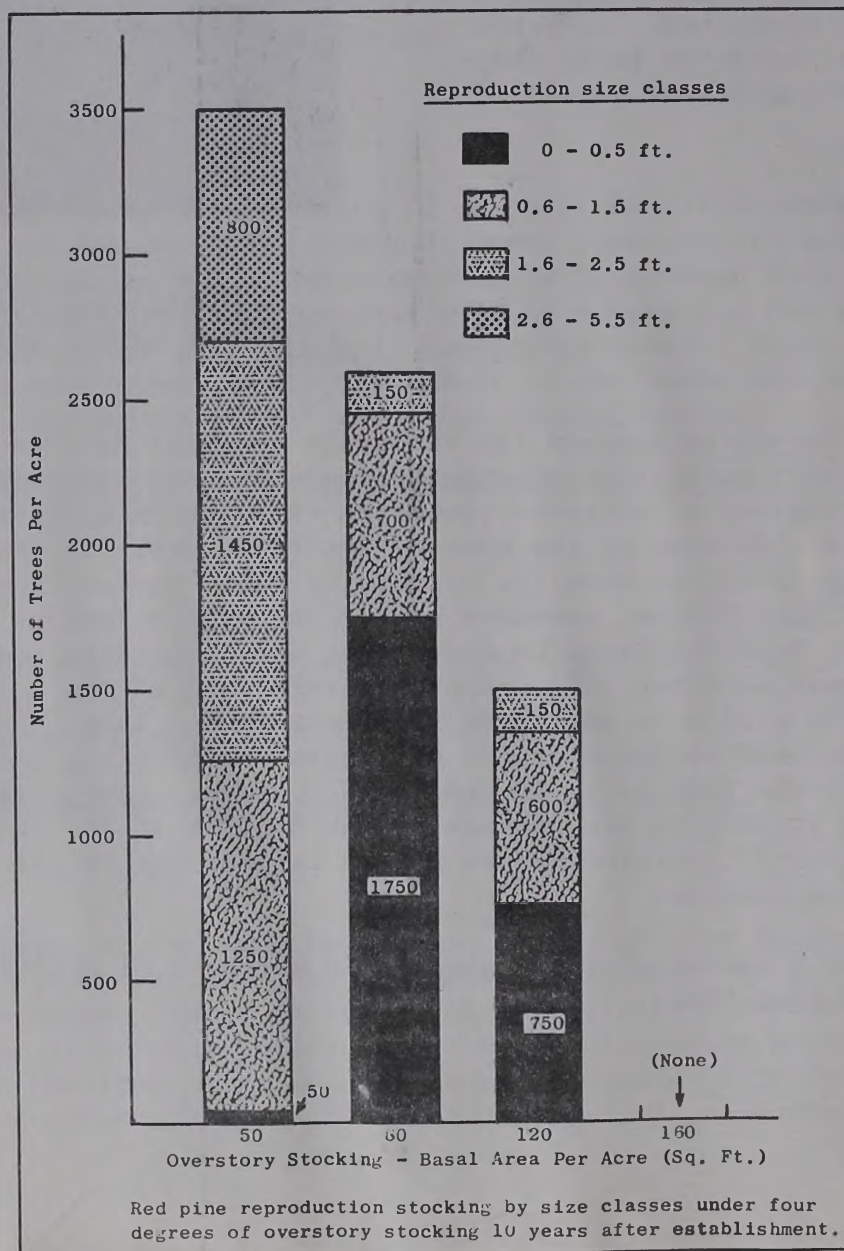
Results from a number of these studies in northern Minnesota became available during 1955.



# Growth of Red Pine Reproduction Under Different Levels of Overhead Stocking

In January 1945 three plots of an older thinning study were cut to contrasting stocking levels to determine the density of overstory under which newly started reproduction would grow best. The three stocking levels were 50, 80, and 120 square feet of basal area per acre; a fourth plot was established in an uncut area which had 160 square feet of basal area per acre. The 10-year reproduction results are shown in the accompanying chart.

This study substantiates other observations (Technical Note No. 392) that reproduction will get started under medium to dense overstory stocking, but that for good development of this reproduction, the overstory must be reduced to about 50 square feet of basal area.





### Heavy Thinning Improves Quality of Jack Pine Stands

Heavy thinning of jack pine stands, started at an early age, has improved the quality of the stand as judged by the number of trees 9 inches and larger present, although it has reduced the total production from the area. These larger trees will make poles, a high quality use for the species.

This study was established in 1929 with the thinning of an over-dense 20-year-old stand to spacings of 6x6 and 8x8 feet. In 1939, 1944, and 1949 these plots were cut back to stocking levels of 90 and 75 square feet of basal area per acre respectively through commercial thinning operations. Twenty-five years later at age 45, total volume production and stand quality on the lightly thinned and unthinned area were about the same. The lightly thinned area has produced 40.9 cords per acre and the unthinned 40.5 cords. The heavily thinned plot has somewhat less total production to date, 37.4 cords per acre, but has substantially more volume in large-size trees. This plot has 110 trees in the 9-inch and larger diameter class compared to 38 for the lightly thinned area and 40 for the uncut check plot.

To reestablish the stocking levels of 90 and 75 square feet of basal area, the plots were again thinned before the 1955 growing season by the removal of 5.5 cords per acre on the lightly thinned plot and 4.0 cords on the heavily thinned plots.

### Lower Michigan Red Pine Poletimber and Small Sawtimber Stands Contain Most of Potential Poles

The fieldwork for an appraisal of the present and potential red pine pole supply in Lower Michigan was completed in 1955 with the assistance of the Michigan Department of Conservation. Sixty stands, including natural and planted ones, were classified by Forest Survey standards at the same time that present and potential poles were tabulated. Partial analysis of the data indicates that only the medium and well-stocked poletimber and small sawtimber stands can contribute substantially to the present and potential pole supply (see table next page).

Sweep and crook are the major pole defects in these stands. In the large sawtimber stands and in all poorly stocked stands the presence of branch whorls with an aggregate branch diameter of 6 inches or more causes the rejection of more trees than do sweep and crook combined. Estimates of the number of trees potentially suitable for poles are generous since no allowance could be made for possible losses from mortality, ice damage, trees cut for pulpwood, and growth of branches in thinned stands. A high proportion of both the present and potential pole trees will be crop trees in stands



managed for sawlog production, and only a small portion of the trees cut in intermediate harvest will be usable for poles. A landowner interested in producing poles may have to maintain a stocking of around 140 square feet per acre from age 35 to 40 years until the height to live crown will reach 35 to 40 feet. Then the stand may be opened up to increase the diameter growth of the pole trees without fear of obtaining whorls of large-diameter branches.

Stand size class	Stocking class		
	Good	Medium	Poor
<u>Trees now suitable for poles (per acre)</u>			
Large sawtimber	6	2	0
Small sawtimber	34	19	3
Poletimber	3	0	0
<u>Trees potentially suitable for poles (per acre)</u>			
Large sawtimber	0	0	0
Small sawtimber	34	46	32
Poletimber	147	69	5

SWAMP            Although long-term predictions of timber demands are difficult to make and uncertain, economists generally agree that consumption of pulpwood, both per capita and in total amount, will continue to increase rapidly in the future, as it has in the past few decades. Largely through necessity, species such as aspen and other hardwoods are being used in important and increasing quantities in pulping processes, but the spruces are still the desired species in the Lake States. Demands upon the swamp conifer stands, composed largely of black spruce, will undoubtedly continue heavy in the future. Improvement of the spruce supply situation by better management methods will become increasingly critical to the pulp industry of the region.

Of the 6,300,000 acres of swamp conifers in the three Lake States, about 2,700,000 acres are poorly stocked. Consequently, much effort has been directed toward developing better and more sure methods of reproducing swamp conifers. In addition, a number of studies of growth following intermediate cuts have been established to insure the most production from present growing stock.



Factors Affecting  
Black Spruce Reproduction

Preliminary results of cutting studies begun 4 to 6 years ago in the Big Falls Experimental Forest of northern Minnesota, in cooperation with the Minnesota Division of Forestry, point out some interesting relationships between black spruce reproduction and ground scarification, slash accumulations, and density of residual overstory. The following three tables, giving the results of examination of 1,820 milacre reproduction quadrats, show that for all cutting methods the percent of quadrats stocked with established black spruce seedlings (1) increased as the proportion of the quadrat covered by a strip-road increased, (2) generally decreased as the proportion of slash (which accumulated in large quantities with heavy cuts) increased, and (3) decreased markedly with an increase in the overstory, although the percent of quadrats stocked with seedlings of any species--primarily black spruce, tamarack, and balsam fir--decreased relatively little.

Effect of strip-road scarification

Percent of quadrats scarified by strip-road :		Percent of quadrats stocked with established black spruce seedlings					
:	:	Clear-cut	Clear-cut	Shelter-wood	Group selection	Tree selection	Even-age:
		patches	strips	:	tion	tion	light partial cut : Check (uncut) :
0		36	12	31	12	20	9 6
1 - 30		49	64	62	17	42	27 -
31 - 60		74	44	88	55	47	40 -
Over 60		94	75	100	41	54	<u>1</u> /0 -

1/ Result based on less than 10 quadrats.

Effect of slash density

Percent of quadrats covered by slash :		Percent of quadrats stocked with established black spruce seedlings					
:	:	Clear-cut	Clear-cut	Shelter-wood	Group selection	Tree selection	Even-age:
		patches	strips	:	tion	tion	light partial cut : Check (uncut) :
0 - 20		73	42	48	18	16	12 6
21 - 40		57	31	33	8	25	10 -
41 - 60		21	15	7	20	19	5 -
61 - 80		6	10	<u>1</u> /0	<u>1</u> /0	9	<u>1</u> /0 -
Over 80		0	0	<u>1</u> /12	<u>1</u> /20	<u>1</u> /0	<u>1</u> /0 -

1/ Result based on less than 10 quadrats.



Effect of overstory density  
(all cutting methods combined)

Percent of full crown canopy	:	Percent of quadrats	:	Percent of quadrats
	:	stocked with any	:	stocked with
	:	species or quality	:	established black
	:	of reproduction	:	spruce seedlings
0 - 10		60		44
11 - 35		58		36
36 - 60		55		26
Over 60		42		12

Two studies have been initiated within the past year to test the management implications of these early observations. In one, a bulldozer was used to destroy the brush and to prepare the seedbed for natural regeneration. In the other, comparisons will be made of natural regeneration in clear-cut strips where no slash disposal is made, where slash is burned in windrows, and where slash is removed from the strips.

**BALSAM FIR-SPRUCE** Important acreages of this type exist in each of the three Lake States, and, with the natural transition from aspen to balsam fir on certain sites coupled with the relative ease with which balsam fir reproduces itself, the acreage of the type will probably increase in the future. Demand for long-fiber pulping species is expected to continue heavy in the future, and, although yields of pulp from balsam fir are inferior to those from spruce, the more abundant balsam fir should help to supplement spruce, which already is in short supply. For these reasons, increased attention is being given to the management problems in this type.

Cooperative Cutting Study  
Installed

During 1955 a 60-acre cutting experiment was installed in 35-year-old pure balsam fir in cooperation with Kimberly-Clark of Minnesota on the Company's Sand Lake Experimental Forest. Here growth under five cutting methods will be contrasted. The Company handled the job as a commercial logging operation, and various cost aspects were studied.

Enough pulpwood (7.5 cords per acre) was produced from the 5-inch diameter limit cutting to more than pay for the work, but where there was no immediate cash return the residual stand is in better



shape to produce high yields in the future. Spruce budworm is established in the surrounding area and one interesting aspect of the study will be the effect of various types of cutting on infestation by this insect.

OAK     A better understanding of the ecology of the various species of oaks is an absolute requisite to managing this forest type. Because of the dearth of such information, the majority of the silvicultural operations made to date in the mixed oak forests of the Lake States have been on a cut-and-try basis.

Oak Reproduction Requires  
Minimum Competition and Maximum Light

Unlike northern hardwood stands, protection and sustained yield cutting methods alone will not assure the perpetuation of oak woodlands. Oak stands which have not been burned or grazed for 30 to 40 years have been examined in southern Wisconsin and Minnesota and found devoid of advanced reproduction of red oak, the principal species of the overstory. These areas often have a number of young oak seedlings present, but none survives long enough to become well established. Recent studies indicate that such seedlings can be encouraged by increasing the amount of light at the ground level.

Measuring the height of a 3-year-old northern red oak seedling. This study in southwestern Wisconsin seeks to evaluate factors affecting oak reproduction.





Removal of the overstory of mature oak on the Dundee Timber Harvest Forest near Fond du Lac, Wisconsin, by clear cutting in 1951 resulted in growth of about 1,200 oak seedlings from an average height of 7 inches to an average of 36 inches in the 5-year period since logging. This height was achieved despite a rapid growth of competing blackberry and other woody shrubs that on portions of the area formed an almost light-impervious canopy at the end of the 1952 growing season. Such shrubby growth is hazardous to growth and survival of the oak seedlings as shown by losses of 80 percent under very dense shrubs as compared to only 36 percent under shrub cover of sparse to medium density. Within 2 or 3 years a large number of the oak seedlings, which are now 3 feet tall, should be breaking through the overtopping shrub canopy. Such growth is not found under the cover of mature oak stands.

Additional evidence of the benefits of providing red oak seedlings with a maximum of light and a minimum of competition has been obtained on the Hardies Creek Timber Harvest Forest in Trempealeau County, Wisconsin. Acorns were seeded in rows in a clearing in a mature oak stand. The herbaceous and woody vegetation was allowed to develop on half of the rows; on the other half all overtopping vegetation was cut back annually. At the end of the fourth growing season in the fall of 1955, survival, in percent of established seedlings at the end of the first growing season, was 86 percent on the weeded areas and only 68 percent on the unweeded areas. Heights were 15.0 and 11.8 inches for trees on the weeded and unweeded areas respectively.

The height growth advantage of the weeded over the unweeded seedlings has become progressively greater during the 4 years. These experiments indicate that considerable light, obtained by removal of the overstory of mature oak is necessary for successful growth of the numerous red oak seedlings that are often found in unburned and ungrazed stands.

NORTHERN        Northern hardwood stands occupy approximately 9½ mil-  
HARDWOODS        lion acres in the Lake States. A variety of indus-  
tries, including furniture, flooring, chemical, wooden-  
ware, and veneer companies, has been built upon the products of  
these stands. Much of the cut of northern hardwoods comes from vir-  
gin old-growth stands located mainly in the Upper Peninsula of Mich-  
igan, but more than three-quarters of the type is in second-growth  
stands. Much of the Station's activity in northern hardwood manage-  
ment research has been directed toward methods of harvesting the  
old-growth timber so as to perpetuate the resource.

Although northern hardwood stands reproduce readily following cut-  
ting, obtaining reproduction of the more desirable species is a  
problem. The survey of productivity of cutover lands, a part of



the Timber Resource Review, showed that changes in stand composition toward the less desirable species were widespread in northern hardwood types. Indiscriminate commercial cutting takes the species that are most valuable and leaves the less valuable ones to occupy the site.

#### Stand Quality Improved Under Group Selection Method

Twenty-six-year results of group selection management in old-growth northern hardwoods show good growth on the area and a reduction in average cull percent for the third cut made in 1955. These two facts indicate that group selection methods, which create openings by cutting groups of trees rather than single scattered trees as in the selection system, can produce good results in this type of timber.

The first cut, made in 1929, created openings about 1/10 acre in size scattered evenly throughout the stand. Subsequent cuttings in 1944 and 1955 created some new openings and enlarged some of the older ones. These large openings are designed to favor the less tolerant but more valuable yellow birch over the very tolerant sugar maple.

Detailed plot records show that the total number of trees 1.6 to 9.5 inches in diameter has increased since 1944, but that the percentage of yellow birch has remained relatively stable. Severe competition from sugar maple prevented an increase in the proportion of yellow birch. Periodic annual growth has been increasing since the first cut and was approximately 300 board-feet per acre between 1949 and 1954.

#### Paper Birch Site Requirements Being Investigated

A study was started during 1955 in cooperation with a number of wood-using industries to determine the site factors which influence the growth of paper birch in northern Wisconsin. Paper birch stands will grow on a variety of sites, and may develop into any size from material too small to be merchantable even for pulpwood to veneer size logs. The

Soil profile studies are made on each sample plot for paper birch site investigation in northern Wisconsin.





study will investigate stands on a range of major soil types in the area to find measurable site factors which can be used to predict the quality of paper birch stands a given site will produce. Data gathered so far indicate that soil texture, depth to water, topography, and fire history are the important factors.

#### Abundant Reproduction Follows Cutting in Second-Growth Stands

In the winter of 1951-52 several different cutting methods were tried in second-growth hardwood stands on the Argonne Experimental Forest. The methods used include: (1) Tree selection (cut to 60, 75, and 80 square feet of basal area per acre), (2) group selection, (3) clear cut, (4) strip cutting, (5) 8-inch stump diameter limit, and (6) uncut.

When counts were made 1 year after cutting, there was an average of 40,000 to 50,000 hardwood seedlings per acre on all treated areas. This year (4 years after cutting) counts revealed large reductions (65 to 75 percent) in number of sugar maple on all treatments except tree selection and the uncut timber. Birch seedlings showed an even more pronounced drop in number since 1952.

Even with the large decrease in numbers of seedlings, plots in all treatments are well stocked with various combinations of sugar maple, ash, and birch.

ASPEN      Recent forest inventories in the Lake States show no reduction in the aspen type, which was established on large acreages of burned-over or cutover land early in this century. Demands upon aspen, largely for pulpwood, are increasing. These facts point out the need for giving high priority to continuing research in the aspen type.

#### Aspen Site Factor Relationships Study Continued

Because aspen grows on a wide variety of sites and since the products of different sites vary from non-merchantable material to trees suitable for veneer and lumber, it is important that foresters be able to recognize site quality of aspen lands. In 1953 the Station, with the assistance of the Minnesota Office of Iron Range Resources and Rehabilitation, initiated a study of the site factors that control aspen growth and development.

Some of the results of the preliminary field work were mentioned briefly in last year's Annual Report. During 1955 published material on aspen site factors was assembled and reviewed in Station Paper No. 32, "A Review of Literature Relating to Quaking Aspen



Sites." Part of the field data were also collected for testing tentative site-prediction methods, using topography, soil texture, depth to water table, fire history, and presence of alkaline soil reaction as indicators of site quality.

**MENSURATION** Estimation of timber volume and growth enters every problem of forest management and stand evaluation. The varieties of forest types and conditions occurring in the region present many problems requiring different procedures and orientation. As forest management practices continue to expand, so too does the need for volume and growth information.

Forest Mensuration also includes the use of statistical methods. It now provides an all-Station service in setting up proper sampling techniques and experimental designs and in analyzing and interpreting field data.

#### Composite Volume Tables Published

The development and use of composite volume tables is now explained in the recently published U.S.D.A. Technical Bulletin No. 1104. The bulletin presents six basic composite tables which can be adjusted by means of correction factors to fit any particular stand. Their proper use requires evaluation of significant differences in form class of trees, bark thickness, taper associated with species and the condition of the stand, degree of utilization, and local practices. The tables have been tested and have been found to be a satisfactory replacement for the numerous local species volume tables formerly used in the Lake States.

#### Point Sampling Found Advantageous Under Certain Conditions

A study of plotless cruising under Lake States conditions has been made in cooperation with the Timber Management Division of Region 9. Five typical forest condition classes were selected for the study. Each condition was represented by a 10-acre block, cruised 100 percent, and from 20 to 29 sampling points were taken in each block to test the accuracy of plotless cruising. The results of this study so far indicate the following: (1) Point sampling by the 10-factor is quite similar to cruising by means of very small plots, especially in pulpwood timber, (2) about twice as many estimating points are required by 10-point sampling to match the accuracy of regularly employed 1/5-acre plots, and (3) plotless cruising works to an advantage in uniform even-aged and pure stands, where only a few species are involved, all trees are about the same size, and the spacing between trees is uniform.



PLANS            During 1956 the tree improvement work will be well es-  
FOR 1956        tablished, with new facilities and a program of research  
                 in being. The need for adequate information on traits  
of superior trees for immediate use in silviculture and management  
must be balanced off against the desirability of beginning studies  
of long duration. Both jobs will be carried forward in 1956.

Use of herbicides in forest management has been emphasized in re-  
search during the past year. Aerial application, in particular,  
has received much attention. The need for studies under more care-  
fully controlled conditions has led to the development of equipment  
for simulating aerial application, and this will be used for inten-  
sive tests during the coming year. The Station will continue to  
encourage interchange of information and experience through such  
gatherings as the aerial brush control meeting reported for 1955.

In the field of silviculture, information is being gathered together  
on growth requirements and environmental associations of several of  
the more important species in the region so that up-to-date summar-  
ies will be available in usable form. This work will be pushed  
aggressively during the coming year.

New work on reproduction of key species, and on response of resid-  
ual stands to various cutting methods, will be limited by the need  
for maintaining studies already under way. Problems needing imme-  
diate attention are proper stocking levels and improvement cutting  
specifications for second-growth northern hardwoods, more econom-  
ical regeneration procedures for cutover pine areas, better cover-  
age in balsam fir cutting studies, and requirements for satisfac-  
tory northern red oak reproduction. Research will be intensified  
on these problems to the greatest possible extent.

Research on pine plantation management has progressed far enough so  
that a summary of information appears desirable--at least for Lower  
Michigan conditions. Compilation of such a summary is scheduled  
for 1956.

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## W A T E R S H E D   M A N A G E M E N T

Water supplies are becoming more critical in all parts of the United States because of increased population, greater industrial use, and land-use practices that have reduced the amount of water infiltrating the soil. In some sections there is a definite deficiency in the amount of water available. In others, insufficient water of usable quality may present a problem. Often these deficiencies are coupled with serious erosion problems.

The relationships of forest cover to water control and use have received little study in the Lake States region. In the most obvious erosion problem area, the unglaciated portion of southeastern Minnesota and southwestern Wisconsin, some work was done in years past, but the initial effort could not be sustained. As time goes on, the need becomes greater for defining more clearly the role of forest cover in the water cycle of the Lake States.

As a preliminary step, the needs of the region were surveyed during the summer of 1955 through a cooperative arrangement with Michigan State University. Results of the survey will be made available as soon as data and observations have been summarized. Completion of the project is scheduled for 1956.

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## F O R E S T   U T I L I Z A T I O N

According to the Timber Resource Review, the overall demand possibilities for timber and wood products of all kinds, including those for woodpulp, are much greater for the future than previous reports have indicated (see Industry Analysis on page 18). If timberland owners--federal, state, and county, small farmers and large industrial corporations--are to obtain the benefits of wood's full potential as an industrial raw material, giant strides must be made in research, development, and promotion of wood uses, and in the management of the timber resource.

If the Lake States region is to participate fully in supplying these potential requirements, its resources of hardwood timber including aspen and the denser hardwoods such as maple, oak, and birch must be utilized more fully. Here is where research enters the picture: Its job is to develop new uses, new products, and



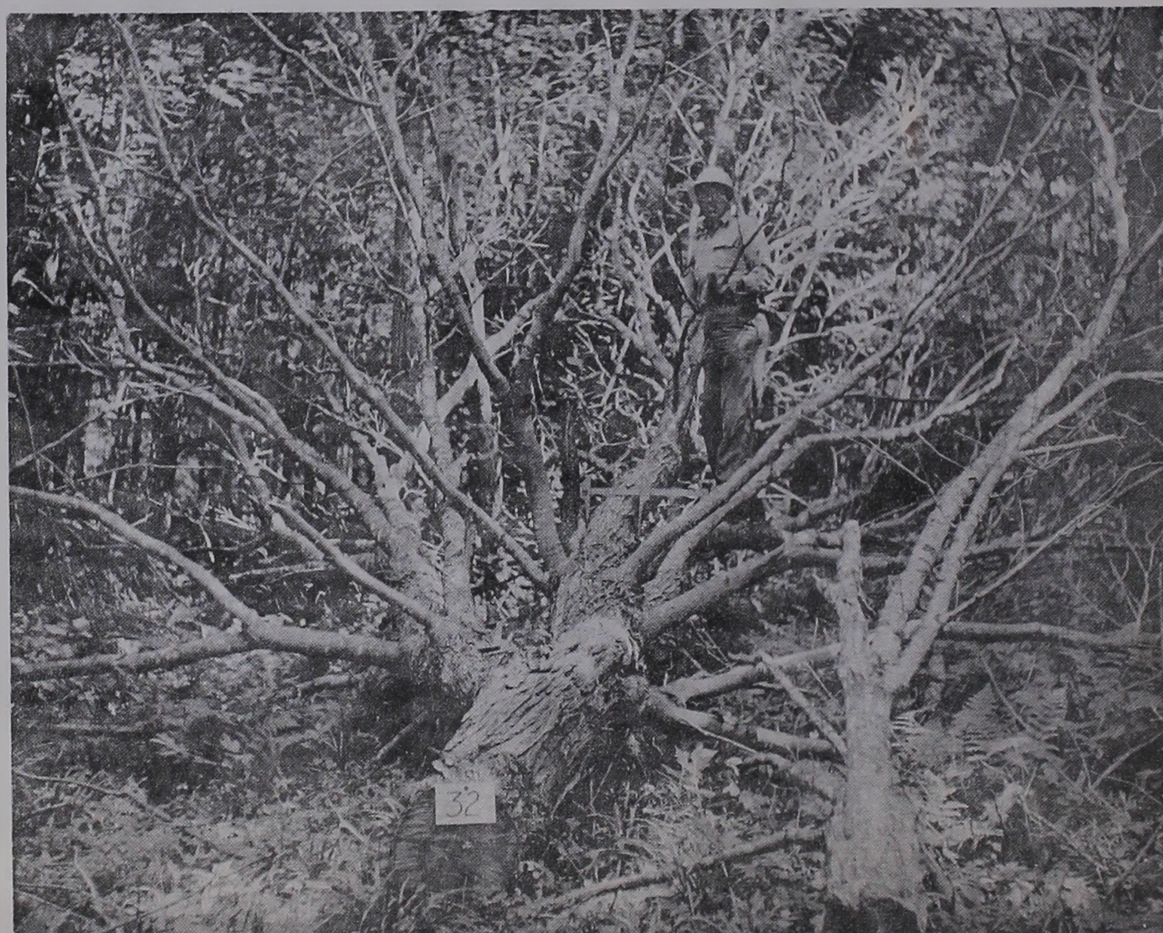
economic methods of harvesting and processing. These and many other active lines of research are essential to the continued improvement and development of the timber resource which is such a vital part of the area economy.

The major studies relating to wood utilization are described in the following pages. It will be noted that all of them are conducted in cooperation with other agencies, schools, or industries. Without their aid, progress in this field would be limited because of the need for expensive installations and machinery.

#### Logging Residue Evaluated

A significant quantity of wood is left in the forest after improvement cuts and harvesting of hardwood sawlogs. It consists of tops, limbs, cull logs, cull trees, low-grade logs, and short-length sections of high-grade material. The present practice of leaving this material to decay and become unusable is due in part to lack of markets that will use it without further processing and in part to the lack of efficient methods and equipment for extracting and processing it. Inability to remove and utilize this material economically creates an unfavorable situation for proper silviculture

Residue in topwood varies greatly from tree to tree:  
heavy top at left, light top at right.





and good forest management practices. With the increasing use of hardwood forests as sources of wood fiber as well as lumber, the material that is left in the woods after conventional logging operations takes on added importance.

Under a cooperative agreement with the Forest Products Research Division, Michigan College of Mining and Technology, a survey of this material was made during the summer of 1955. The residue created by the cutting of 500 trees in managed stands in eight Upper Michigan locations was classified and measured.

The following table presents the volume of residue created per thousand board-feet (log scale) removed. It was made up from that portion of the data which is considered most reliable because no products other than sawlogs had been removed at the time of measurement.

Volume of residue per thousand board-feet<sup>1/</sup>  
(Scribner Decimal C)

Species	: Trees	: Total : residue	: Limbs	: Tops <sup>2/</sup>	: Long butts			
	<u>Number</u>	<u>Cu.-ft.</u>	<u>Cu.-ft.</u>	<u>Pct.</u>	<u>Cu.-ft.</u>	<u>Pct.</u>	<u>Cu.-ft.</u>	<u>Pct.</u>
Hard maple	206	53.79	38.27	71	8.21	15	7.31	14
Yellow birch	89	52.10	40.65	78	8.34	16	3.11	6
Soft maple	23	55.26	43.44	79	9.50	17	2.32	4
Beech	30	91.92	78.23	85	12.06	13	1.63	2
Red oak	14	54.74	31.39	57	12.01	22	11.34	21

<sup>1/</sup> Gross volume based on d.b.h. and height to nearest half log.

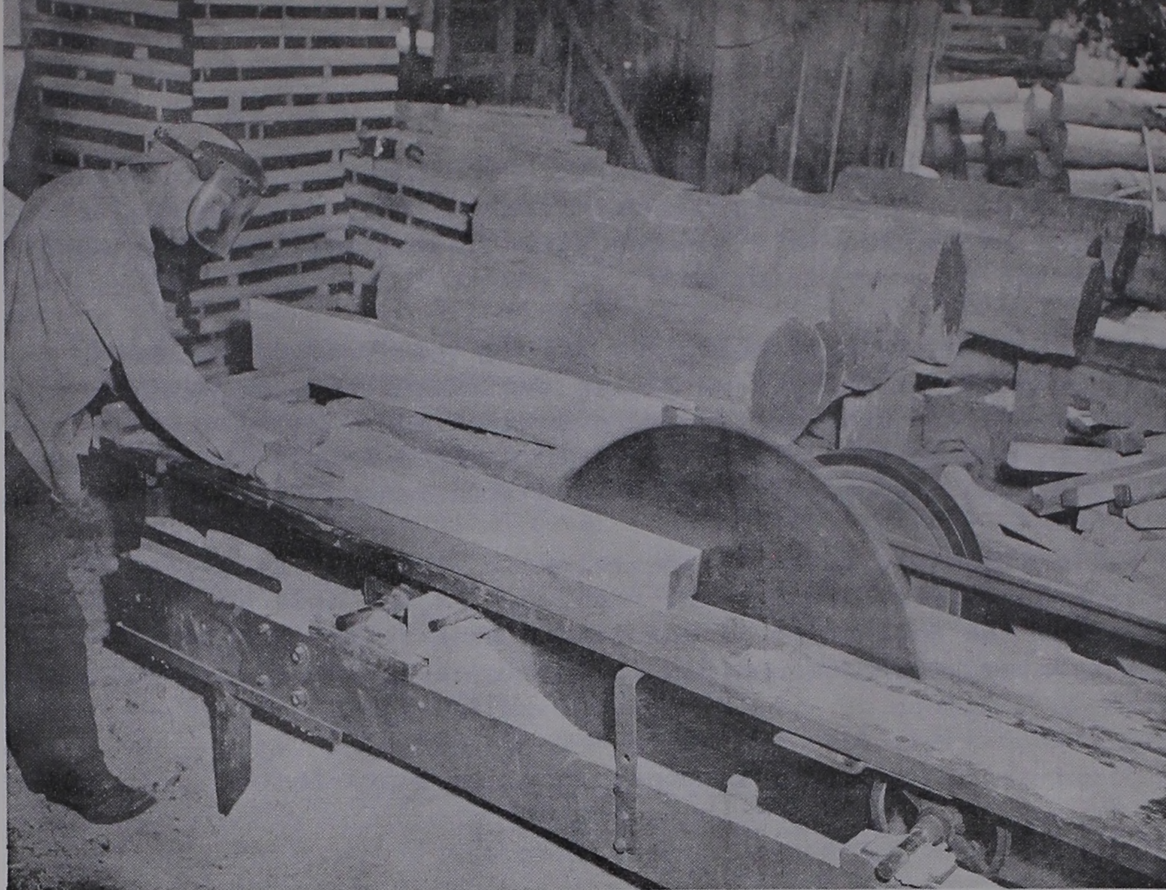
<sup>2/</sup> That portion of the bole between the top sawlog cut and the first major limbs.

More detailed analysis is under way and the results will be presented in a special report. The primary objective of the analysis is to develop information that will aid in drawing up specifications for equipment to harvest residue material. This harvesting will be the subject of later phases of the hardwood logging residue study.

#### Low-Quality Trees From Improvement Cutting Utilized as Dimension Stock

The practice of sawing hardwood dimension stock from short logs or bolts has not been developed in the Lake States region on a commercial basis. An exploratory farmwoods utilization study in Lower





Production of dimension stock from beech bolts.  
Grade recovery from short bolts was higher than  
the recovery that could be expected if the trees  
had been cut into standard logs.

Michigan showed that cutting low-value beech, 11 to 19 inches in diameter, into 52-inch bolts instead of standard logs can increase lumber yields by 25 percent. A mill tally by grades indicates that the grade recovery from the short bolts was higher than the recovery that could be expected from mill-run lumber if the trees had been cut into standard logs. The study also showed that grade recovery from the bolts is controlled by bolt quality--the number of clear faces per bolt--and not by bolt size.

The dimension stock produced is being used for a kiln drying study in cooperation with the University of Michigan. The effects of kiln schedule, weighting, end coating, and grade on drying losses will be investigated. The first run of 8/4 dimension stock under this study was completed in November. Much of the degrade from warping in the Common grade was accentuated by the twisted grain around the knots. Apparently both weighting and end coating have had some effect, but the final evaluation must wait until the measurements are complete and the results analyzed.

#### Factors Affecting Weight as a Measure of Pulpwood

The primary objective of a study instituted in July 1955 in cooperation with the School of Forestry at the University of Minnesota is to obtain information on seasonal changes in the moisture content



of standing jack pine trees. At the present time two mills in Minnesota are buying aspen and jack pine on trucks by weight. A large seasonal fluctuation in moisture content could cause some complication in the use of weight as a basis for purchase. Previous research on trembling aspen at the School of Forestry has shown that standing trees have an additional 30 percent in moisture content in winter compared to summer. This is enough to increase weight per cord by 17 percent.

Other phases of this project are concerned with the rate of drying of cut jack pine pulpwood and the development of more efficient methods of sampling standing trees and cut pulpwood for moisture content and specific gravity. Preliminary observations indicate that over a 2-month period in late summer freshly cut sticks lose about twice as much moisture as those deeper in a stack of pulpwood. When more information on rate of drying is available, it may have considerable importance to those holding pulpwood for any period before selling it by weight.

#### Preservative-Treated Wood in Farm Structures

For several years this Station and the School of Forestry and other branches of the University of Minnesota have cooperated in fencing studies and in investigations of preservative treatment of wood products such as posts, poles, and native lumber for farm use. Studies of farm fencing with preservative-treated wood posts were continued during the year and several new installations were made.

A structure, begun last year in cooperation with the University of Minnesota to effect a satisfactory pattern of use of treated lumber in farm buildings, has been completed. This study of a wood structure has three main objectives:

1. To test the economic feasibility of double-wall, pole-type construction, using commercial batt-type insulation and a complete vapor barrier.
2. To study the use of preservative treatment with native jack pine and red pine lumber for such a structure.
3. To test new designs in ventilation, wall and pen construction, and the possible use of a pigmented "penta" preservative in place of paint for outside wall protection and beautification.

The test structure, a 98x30-foot pole-type hog house, built of native red and jack pines, is at the Rosemount Research Center, University of Minnesota. To facilitate uniform double-wall construction so that insulation and a tight vapor barrier could be used, the poles were sawed on four sides, above ground line. Below



ground line the poles were left round to secure maximum preservative treatment. All of the poles, splash boards, and other materials which may be subject to rapid decay were treated either with pressure creosote, hot-cold "penta," or vacuum "penta."

The inside walls and ceiling were covered with random-width matched lumber. These boards were given a 2-minute dip in a clear "penta" solution containing a water repellent. Untreated control panels were left on each of the inside walls and ceiling. Panels of lumber, vacuum treated with "penta," were also used.

Vertical stockboards and batts were used for the outside walls. Part of these stockboards were treated (2-minute dip) with a "penta" solution containing a dark-colored ground pigment. Boards for other sections were treated with a 2-minute dip in a clear "penta" solution containing a water repellent. Boards for other sections were given a vacuum "penta" treatment. Control panels of untreated boards were left in each wall.

The ceiling is built with a 3/4-inch opening into the attic on all sides. The attic is also open to the outside at the eaves so that when the fans are in operation there is a gentle flow of air into the hog area without draft. Concrete and bituminous material is used on the floor. Pen partitions--all made of wood--were given different types of preservative treatment, with some left as controls.

The barn has now been in use for a year. Several years must elapse before its weak and strong points can be evaluated.

#### Use of Low-Grade Wood in Agriculture

In much of our northern farm area, obtaining bedding material for livestock is a major problem. Also, soils are frequently deficient in humus and of low fertility. Wood chips used as bedding and subsequently applied on the land might be one answer to furnishing a profitable outlet for forest material not otherwise usable.

The Station will cooperate with the North Central School Experiment Station, University of Minnesota, in experimenting with the production and use of chips for these purposes. A chipper has been supplied by the Station.

#### Charcoal Production in Small Kilns

Progress was made during the year in the study of charcoal production in small field-type kilns, and general interest in this means of utilizing low-quality hardwood has remained high. Two of the area's largest producers of charcoal and wood distillation products

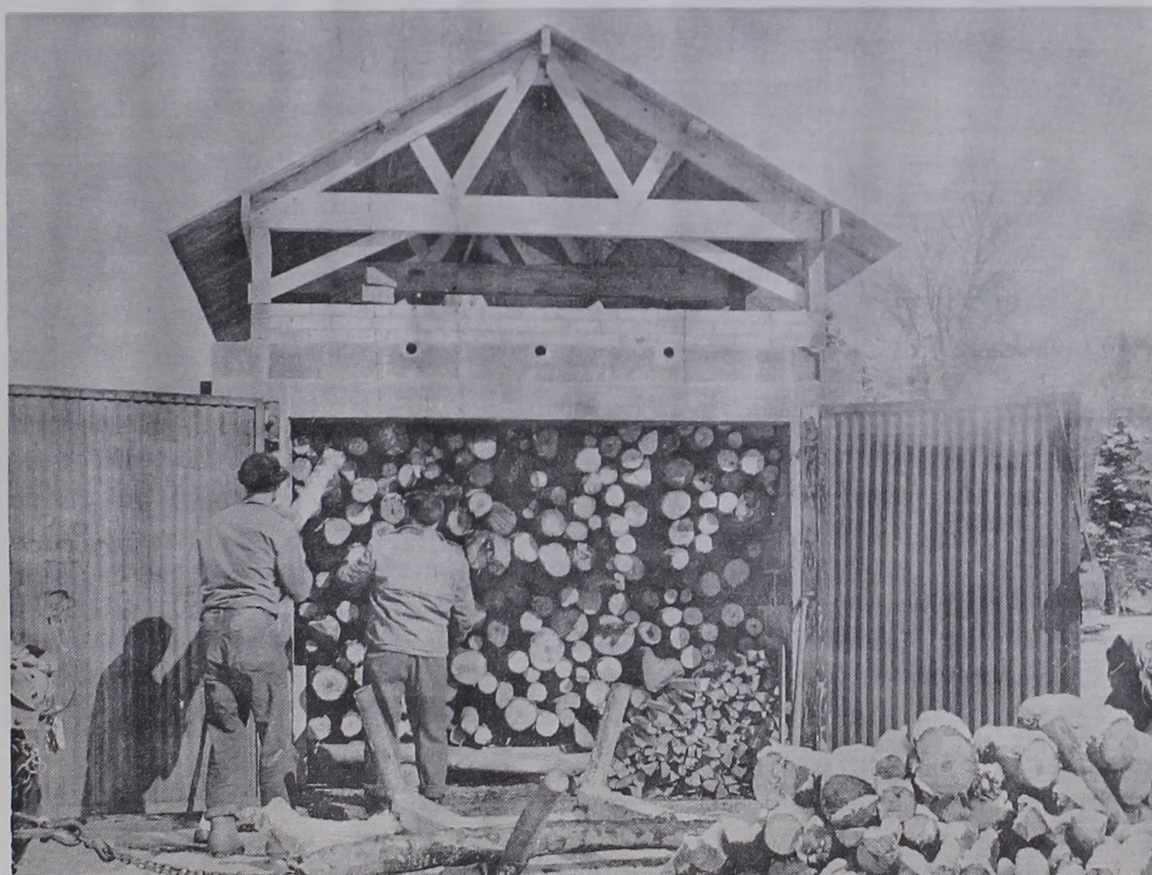


are cooperating with the Station in these studies. The Forest Products Laboratory has continued to provide technical guidance and designs for experimental units of the study, including analysis of charcoal produced. A total of 37 burns were carried out at three study locations, each having a somewhat different phase of charcoal production for investigation.

The charcoal study at St. John's University is a cooperative project of the Office of Iron Range Resources and Rehabilitation, the Forest Products Laboratory, University of Minnesota, St. John's University, and this Station. The purposes of this study are to determine the most economical method of operating the kiln and whether small mill or woodlot owners can erect and run similar kilns profitably. The kiln design and the materials used in the construction are being tested and evaluated as the study progresses.

In a period of 1 year, 25 burns have been run through the Minnesota kiln with varying degrees of success depending on the methods of operation used. The types of charges varied from slabs to roundwood and were composed of a varied number of species including both hardwoods and softwoods. The moisture contents varied from 16 to 50 percent based on oven-dry conditions. Data have been collected and recorded from each burn including the material balances, operating temperatures, carbon dioxide levels, moisture determinations, and other observations of kiln behavior.

The charcoal kiln on the Argonne Experimental Forest is being charged with low-quality wood from improvement cutting.





Another phase of the Station's charcoal research program was conducted at an experimental kiln near Three Lakes, Wisconsin, on the Argonne Experimental Forest. This kiln, an 8-cord, cinder-concrete block unit, was completed in March, and eight experimental burns were carried out during the year. The principal objectives of investigations are (1) to develop and test kiln designs, (2) to develop commercial operating techniques and schedules, and (3) to determine the suitability of low-value trees and sawmill waste for the production of kiln charcoal.

The eight experimental burns at the Argonne kiln provided considerable information directly applicable to commercial operations. Progress was made in developing techniques for controlling the carbonization process and improving charcoal yield and quality. From the data collected on kiln design and the performance of structural materials, several improved designs are being prepared for new test units and the original kiln will be completely rebuilt.

The third study is on the Dukes Experimental Forest near Marquette, Michigan. The major objective here is to provide a profitable operation by integrating production of charcoal with stand improvement thinnings. Various methods of handling, storing, loading, and hauling of wood and charcoal will be tested. Kiln operating schedules will be studied to determine procedures that will yield the best quality and greatest quantity of charcoal per unit of wood. Structural problems of both design and materials in low-cost units will be observed.

Although structural failures due probably to the properties of the blocks used in this unit rendered it unusable for further tests after the fourth burn, experience substantiated the premise that good yields of high-quality charcoal can be produced in small woods-located kilns. The various phases of this study will be continued with a unit of new design and materials.

The harvest phase of the study has progressed satisfactorily, and logging on the first replication of 40 acres is about completed. To date approximately 160 cords of charcoal wood have been stacked at the kiln site and all sawlogs and pulpwood have been marketed by the operator. A second replication of the second-growth study has been laid out and the timber marked for removal.

#### Hardwood Tree Quality Specifications for Buyers and Forest Managers

The wood-using industries and timber landowners have been concerned for many years with the problems of determining timber quality. The Lake States Station has initiated a long-range program to develop methods for evaluating hardwood timber quality--methods that can be readily applied by the timber buyer or forest manager. The program includes studies to determine how timber quality is affected by factors such as growth characteristics of the tree, logging methods,



insect and disease damage, pruning treatments, and various methods of cutting and stand management.

The wide spread of value between chemical wood and veneer logs makes tree quality appraisal in the northern hardwood type an essential part of effective silvicultural practices and optimum marketing of timber. A preliminary study, in cooperation with the Schneider Brothers Lumber Company of Marquette, Michigan, has been completed. In this study a partial cut was made on a 6-acre tract of old-growth northern hardwood forest yielding about 100 trees, mostly sugar maple, ranging from 11 to 32 inches in diameter at breast height. Trees removed were mature, overmature, defective, or in direct competition with superior individuals. Each tree marked for cutting was graded on the basis of the number of clear faces in the "grading zone" (the second quarter of the merchantable bole length above stump height). A clear face was defined as one-fourth of the surface of the grading zone without any defects (knots, branches, etc.) readily visible from the ground. Five grades were recognized: Prime (4 clear faces), #1 (3 clear faces), #2 (2 clear faces), #3 (1 clear face), and below grade (no clear faces). In addition, notation was made of defects or external evidence of cull in the tree to modify or supplement the grades based on clear faces.

Each log was identified by tree and position in the tree, diagrammed by the Forest Products Laboratory system, and graded according to standard Forest Service log grades. As the logs were sawn at the mill, every salable unit derived from each log was identified and graded by a National Hardwood Lumber Association inspector.

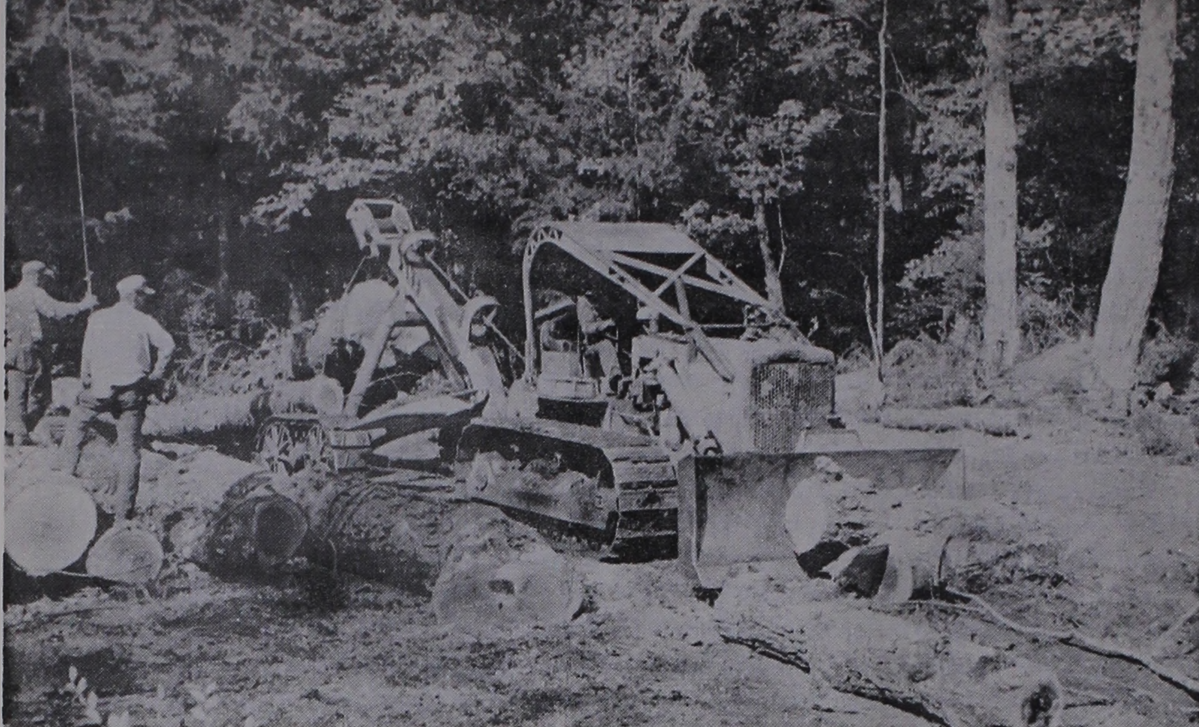
It is evident from this study that a reasonably effective stratification of sugar maple tree quality can be arrived at by grading standing trees on the basis of broad diameter groups and number of clear faces in an easily determined grading zone.

The results of this preliminary study must be substantiated by a large-scale, comprehensive, regionwide project. To this end, plans are under consideration for another tree quality study pointed toward establishing tree grade specifications, in cooperation with Michigan College of Mining and Technology and with Schneider Brothers Lumber Company. More work is also needed to determine the influence of unsound defects upon lumber grade recovery.

#### Logging Methods Influence Log Cleanliness

Where old-growth stands are cut under the selection system, leaving many of the better trees to put on additional volumes, logging damage may contribute to stand deterioration.





Skidding methods influence log cleanliness. A large arch (as above) with tree-length skidding produces the cleanest logs.

A cooperative study of logging methods has shown that skidding methods strongly influence log cleanliness. A large arch with tree-length skidding gave the cleanest logs; ground skidding with short logs the dirtiest. Tree-length skidding with a small arch gave logs nearly as clean as skidding with the large arch (see table). No apparent correlation between cleanliness and log size or species was found.

Log cleanliness by skidding method and  
amount of dirt on log surface

Percent of log surface dirty	Percent of net log scale volume <sup>1/</sup> for:			
	Tree-length skidding		Ground skidding	
	Large arch	Small arch	with short logs	
None	49	34	5	
1- 25	27	34	19	
26- 50	16	21	22	
51- 75	7	10	40	
76-100	1	1	14	
Number of logs	1,553	1,586	1,429	
Net log scale (MBF)	138	140	133	

<sup>1/</sup> Percents do not change appreciably when based on number of logs.



Plans  
for 1956

Research in forest utilization in 1956 will continue along the same lines as in 1955: Emphasis will be on improved harvesting and milling methods and equipment, tree quality determination, and product development from low-quality hardwoods. Continuation of studies already established as described in the preceding pages will constitute practically a full load for the technical personnel, although there will be some amplification of one or two of the projects. Of special interest will be the establishment of timber quality studies in connection with growing stock level studies and other silvicultural treatments.

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P U B L I C A T I O N S      I N      1 9 5 5

The reports listed below by subject matter are the publication output of Station personnel during 1955. With the exception of those marked by an asterisk (\*), copies are available for distribution on request. If you wish to receive our publications regularly, we will be glad to place your name on our mailing list.

Forest Management, Silviculture

Anonymous.

Proceedings of the Lake States Aerial Brush Control Meeting and Tour, July 26-28, 1955. L. S. Misc. Report 39, 38 pp., illus. (Processed.)  
(Gives formal papers read at meeting, summarizes informal papers and discussions, and describes areas visited.)

Arend, J. L.

Chemical herbicides as tools in forest management. Soc. Amer. Foresters Proc. 1954: 194-198.

(Discusses commercial chemicals that can be used for herbicides, techniques of application, and operation in forestry work where herbicides can be moneysaving tools.)

\_\_\_\_\_, John L.

Chemical frill girdling in summer and fall gives best results in Lower Michigan. L. S. Tech. Note 438, 1 p. (Processed.)

(After 3 years, oak top-killed by chemical frill girdles in summer and fall showed less sprouting than those top-killed in winter and spring months. Less sprouting was also obtained by placing the chemical frill close to the root collar.)



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Tolerance of conifers to foliage sprays of 2,4-D and 2,4,5-T in Lower Michigan. L. S. Tech. Note 437, 2 pp. (Processed.)

(Light dosages of 2,4-D and 2,4,5-T ester foliage sprays commonly used for aerial application will damage the new growth of most conifers when applied during the active growth period, but have no apparent effect after the new growth has hardened off.)

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\_\_\_\_\_, J. L., and Coulter, L. L.

Aerial applications of herbicides--a promising method for releasing conifers. Down to Earth II(1): 18-20, illus. Summer, 1955.

(Discusses general principles and problems of applying herbicides by airplane.)

Heinselman, M. L.

Timber blowdown hazard in the Rainy River section of northern Minnesota. L. S. Tech. Note 433, 2 pp. (Processed.) Also Blackduck Amer. (newspaper), May 5, 1955.

(Windstorms of sufficient force to cause some blowdown should be expected nearly every year in the Rainy River area. Strongest winds normally blow from a westerly quarter.)

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\_\_\_\_\_ and Zasada, Z. A.

A review of literature relating to quaking aspen sites. L. S. Sta. Paper 32, 61 pp. (Processed.)

(Provides a comprehensive survey of much of the literature concerning aspen sites.)

Roe, Eugene I.

\*Aerial brush control in Lake States forests. L. S. Misc. Report 37, 9 pp. (Processed.)

(Aerial spraying with herbicides seems to offer considerable savings in both time and money in the control of brush and low-grade trees which may be overtopping conifer stands or preventing the establishment of conifer reproduction.)

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\*Brush control in forest management. Abstract of Aircraft and Ground Sprayers Short Course, Univ. of Minn., June 24-25, 1955, pp. 48-51.

(Brush has succeeded fire as the foresters' No. 1 problem. The various objectives of brush control are being reached at considerable savings in effort and cost by the use of chemical herbicides. Airplane spraying can often result in further savings.)

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\*Control of Labrador tea and leatherleaf by foliage spraying with 2,4-D and 2,4,5-T. No. Cent. Weed Control Conf. (1955), 12th Ann. Res. Report, p. 167. (Processed.)

(Labrador tea was found resistant to these herbicides, requiring at least 16 pounds of 2,4,5-T acid applied in fuel oil in the fall for satisfactory control. Equally strong water solutions of this chemical



and of 2,4-D applied in mid-July were much less effective. Leather-leaf was controlled satisfactorily with as low as 5 pounds 2,4-D acid per acre in water solution.)

and Gaylord, George T.

\*Herbicides show promise in controlling grass competition on peat land. No. Cent. Weed Control Conf. (1955), 12th Ann. Res. Report, pp. 167-168. (Processed.)

(First-year results showed that sodium salt of 2,2-dichloropropionic acid applied in mid-July greatly reduced the density and height of lowland "grasses." Applications in May and June, and also of aminotriazole on the same three dates, had much less effect, but sodium polychlorobenzoates were ineffective.)

Rudolf, Paul O.

1954 forest seed crop fair in Lake States. L. S. Tech. Note 426, 2 pp. (Processed.)

(Reports the estimated percentage of a full seed crop of the more important forest tree species in northern Minnesota, northeastern Wisconsin, central Upper Michigan, and Lower Michigan.)

Scholz, Harold F.

Effect of scarification on the initial establishment of northern red oak reproduction. L. S. Tech. Note 425, 2 pp. (Processed.)

(Scarification of soil coincident with good acorn crop tripled amount of northern red oak reproduction over untreated areas. Need for practical means of scarification cited.)

Stoeckeler, J. H., and Arbogast, Carl, Jr.

Forest management lessons from a 1949 windstorm in northern Wisconsin and Upper Michigan. L. S. Sta. Paper 34, 11 pp. (Processed.)

(Makes a general appraisal of damage, discusses damage in individual forest types, and draws conclusions which have practical application for the forest manager.)

Westing, Arthur H.

\*Effects of undiluted 2,4-D and 2,4,5-T in cut surfaces on oak in Lower Michigan. No. Cent. Weed Control Conf. (1955), 12th Ann. Res. Report, p. 168. (Processed.)

(Undiluted amine of 2,4-D, applied in frill girdles at dosages of 1/2 to 2 milliliters per inch of diameter, proved more effective than amine of 2,4,5-T or than esters of 2,4-D and 2,4,5-T.)

Zasada, Zigmond A.

\*Composition and quality objectives for the aspen type in the Lake States. Soc. Amer. Foresters Proc. 1954: 79-82.

(Points out the desirability of setting up quality and composition objectives for the Lake States aspen type in order to assure production of the kinds of products that will be needed. Stresses the importance of recognizing site quality in such a program.)



Artificial Regeneration  
(Seed, nursery, planting, tree improvement)

Anonymous.

Proceedings of the Second Lake States Forest Tree Improvement Conference. L. S. Misc. Report 40, 108 pp., illus. (Processed.)

(Gives formal papers read at meeting on recent progress in forest genetics and techniques related to genetics research, and discusses activities of the Lake States Forest Tree Improvement Committee.)

Arend, John L.

Development of closely spaced red pine, white pine, and Norway spruce after 40 years. L. S. Tech. Note 439, 1 p. (Processed.)

(The growth and development of these three species were compared in 40-year-old abandoned transplant beds on medium site for red pine. Development of red and white pines under these conditions was almost identical. The Norway spruce fell behind in survival and growth.)

Dickerman, M. B.

Recent progress in forest genetics work at the Lake States Forest Experiment Station. In Second Lake States Forest Tree Improvement Conf. Proc. 1955. L. S. Misc. Report 40: 1-3. (Processed.)

(Outlines genetics work at the Station since 1953 and future plans.)

Gevorkiantz, S. R.

Notes on statistical methodology in forest tree improvement work. In Second Lake States Forest Tree Improvement Conf. Proc. 1955. L. S. Misc. Report 40: 74-80. (Processed.)

(Outlines some of the statistical phases involved in tree improvement work with special emphasis on methods for separating effects of heredity from those of environment.)

Nienstaedt, Hans.

Problems of seed and pollen collection, shipment, and storage. In Second Lake States Forest Tree Improvement Conf. Proc. 1955. L. S. Misc. Report 40: 51-53. (Processed.)

(Discusses briefly some of the more important factors affecting the viability of seed and pollen in storage and during shipment, possible methods for speeding up the forcing of male flowers, and germination techniques for pollen and the danger of projecting the results from artificial viability tests to possible behavior under natural conditions.)

\_\_\_\_\_ and Kriebel, Howard B.

Controlled pollination of eastern hemlock. Forest Sci. 1: 115-120, illus.

(Nine different types of bags and bag combinations, chosen for their modifying effects on the environment, were used to isolate male flowers. White cloth bags of cotton broadcloth--160 threads to the inch--gave the best results. Parchment and kraft paper bags were



relatively good. In other bag types seed set failed almost completely.)  
Note: This paper was prepared while employee was a member of the staff of the Connecticut Agricultural Experiment Station.

Roe, E. I.

Forest plantation release--what it is, how to do it. L. S. Misc. Report 33, 29 pp., illus. (Processed.)

(Fully as important as the actual planting of trees is their subsequent protection from competing brush and other weeds. This handbook describes in simple language the various types of release that may be needed to free the trees from these competitors, and tells how to do them.)

Rudolf, Paul O.

Tree races and forest tree improvement. L. S. Misc. Report 35, 8 pp. (Processed.) Also Third South. Conf. on Forest Tree Improvement Proc. 1955: 4-10. (Processed.)

(Emphasizes that a knowledge of racial variation is a necessary basis for forest tree improvement work. Much possible improvement also depends on recognition and utilization of individual tree variation. Points out that studies of both racial and individual tree variation can be combined.)

Scholz, Harold F.

Growth of northern red oak seedlings under variable conditions of ground cover competition. L. S. Tech. Note 430, 2 pp. (Processed.)

(Gives results of a 5-year study of the survival and growth of northern red oak seedlings under dense fern, sparse-to-medium cover of woody shrubs, and a thin turf of grass. Survival was highest under the woody shrubs and lowest under the ferns. Growth in average airdry weight was best on blue grass sod and poorest under the ferns.)

\_\_\_\_\_, H. F., and Hovind, James.

Effect of the micro-site on the condition and early growth of planted black spruce. L. S. Tech. Note 434, 2 pp. (Processed.)

(Height growth and tip elongation of 2-1 black spruce planted on organic-rich plow slices were much better at the end of the second growing season than for the trees planted in sterile, seasonally wet sand on adjacent furrow bottoms.)

Stoeckeler, J. H.

\*An improved seed spot screen and setter. U. S. Forest Serv. Tree Planters' Notes No. 20: 7-8. June. (Processed.)

(Describes seed spot screen adapted to oak, with a special tool devised for setting the cylindrical screens.)

\_\_\_\_\_  
European larch seed sources compete successfully with tamarack during 5-year test in northeastern Wisconsin. L. S. Tech. Note 440, 2 pp. (Processed.)

(Five years after planting, the best lots of European larch--



from Silesia, German Alps, and Czechoslovakia--had average heights of 5.1 to 6.5 feet and survival of 71 to 91 percent, comparing favorably with native tamarack which averaged 5.4 feet and 67 percent.)

\_\_\_\_\_, Joseph H.

Cover crops afford first-year protection for forest plantations against late spring frosts. L. S. Tech. Note 432, 2 pp. (Processed.)

(A cover crop of rye sown in late summer of 1949 on an area planted to trees in spring 1950 was highly effective in reducing damage to sugar maple and white ash from a frost occurring June 16 when temperatures dropped to around 26° F. Because rye is an annual crop, aspen and birch are under test as longer lasting perennial cover crops for frost-sensitive species.)

\_\_\_\_\_, J. H., and Strothmann, R. O.

Early development of native and hybrid aspens. L. S. Tech. Note 427, 1 p. (Processed.)

(Four-year results show trembling aspen, P. tremula, hybrid of German origin to have faster initial height growth, better survival, poorer form than native aspen.)

#### Forest Mensuration

Gevorkiantz, S. R., and Olsen, L. P.

Composite volume tables for timber and their application in the Lake States. U. S. Dept. Agr. Tech. Bul. 1104, 51 pp., illus.

(Suggests the use for any unit of measure of a single table applicable to the average run of timber throughout the Lake States regardless of species; for any stand showing marked differences from the average, correction factors have been developed to make adjustments for these differences.)

#### Forest Protection

##### Fire

Heinselman, M. L.

\*Forest fires are responsible for deterioration of timber quality.

Askov Amer. (newspaper), May 1955.

(Traces the determinating effect of past forest fires on the composition and quality of the present forests of Pine County, Minnesota.)

Mitchell, J. A.

Forest-fire control in the Lake States. Soc. Amer. Foresters Proc. 1954: 163-166, illus.

(Outlines the progress and development of state and federal forest fire effort in the Lake States, and the present situation.)



## Insects

Batzer, H. O.

\*Effects of defoliation by the forest tent caterpillar. Ent. Soc. Amer., No. Cent. Branch, Proc. 10: 27-28, illus. (Processed.)

(A summary of effects of defoliation on aspen mortality, crown dieback, and radial growth with notes on larval feeding preference and cocoon parasitism.)

Bean, J. L.

\*Recent developments in aerial survey techniques. Ent. Soc. Amer., No. Cent. Branch, Proc. 10: 31-32. (Processed.)

(A brief resume of the various methods used in conducting aerial surveys for forest insects.)

\_\_\_\_\_, James L., and Godwin, Paul A.

Description and bionomics of a new red pine scale, Matsucoccus resinosae. Forest Sci. 1: 164-176, illus.

(Presents a technical description of a new scale killing red pine throughout Connecticut and New York. Also discusses its life history, habits, and importance.)

Beckwith, L. C.

Larch sawfly conditions in the Lake States in 1954, a reconnaissance survey. L. S. Misc. Report 34, 8 pp., illus. (Processed.)

(A report on aerial and ground surveys of tamarack stands in the Lake States infested by the larch sawfly.)

\_\_\_\_\_ and MacAloney, H. J.

The more important forest insects in the Lake States in 1954. L. S. Misc. Report 36, 9 pp., illus. (Processed.)

(A coordinated report, based on surveys by Station personnel and by cooperating federal, state, and private agencies.)

Benjamin, Daniel M.

The biology and ecology of the red-headed pine sawfly. U. S. Dept. Agr. Tech. Bul. 1118, 57 pp., illus.

(Brings together scattered information concerning the sawfly and summarizes the biological, ecological, and control studies.)

\_\_\_\_\_, Larson, J. Donovan, and Drooz, Arnold T.

The European pine sawfly on the Henderson State Forest, Illinois, with notes on its biology and control. Jour. Forestry 53: 359-362, illus.

(A discussion of biological and ecological studies and virus-control experiments carried on since the discovery of this pest in Illinois in 1950.)

Drooz, Arnold T.

Head capsule measurements of Minnesota larch sawflies. L. S. Tech. Note 428, 1 p. (Processed.)

(Useful for separating developmental stages of the larvae, and a basis for timing control operations.)



\_\_\_\_\_, A. T.

- \*Tamarack defoliation as related to larch sawfly flight characteristics. Ent. Soc. Amer., No. Cent. Branch, Proc. 10: 26-27. (Processed.)  
(Emerging larch sawfly adults show a preference for oviposition in nearby trees within individual stands.)

\_\_\_\_\_, Arnold T., and Meyer, Daniel.

- Determination of the age of tamarack twigs and an indication of aborted twig elongation. Jour. Forestry 53: 454-455, illus.  
(Heavy defoliation may prevent seasonal elongation of shoots, but annual rings are produced in the arrested buds or twig structure.)

Heller, R. C., Coyne, J. F., and Bean, J. L.

- \*Airplanes increase effectiveness of southern pine beetle surveys. Jour. Forestry 53: 483-487, illus.  
(A brief summary of aerial survey techniques used in locating southern pine beetle infestations, and the advantages and disadvantages of each.)

#### Disease

Anderson, Ralph L., and French, David W.

- Evidences of races of Cronartium ribicola on ribes. Forest Sci. 1: 38-39, illus.  
(Gives evidence for genetic variability of the white pine blister rust fungus obtained by inoculating a clonal line of Ribes hirtellum.)

\_\_\_\_\_, R. L., and Skilling, D. D.

- Oak wilt damage--a survey in central Wisconsin. L. S. Sta. Paper 33, 11 pp., illus. (Processed.)  
(Gives data on losses from oak wilt in eight Wisconsin counties: 2 percent of oak type area infected; 0.3 percent of total volume killed annually; growth impact 11 percent of net growth.)

#### Wildlife

Krefting, L. W., Erickson, A. B., Gunvalson, V. E.

- \*Results of controlled deer hunts on the Tamarack National Wildlife Refuge. Jour. Wildlife Mgt. 19: 346-352, illus.  
(Discusses the results of three hunting seasons with special emphasis on: Number of hunters and kill, distribution of fawn and adult kill, dressed weight of deer, fawn productivity and sex ratio, and relation of hunting to age.)

\_\_\_\_\_, Hansen, H. L., and Stenlund, M. H.

- Use of herbicides in inducing regrowth of mountain maple for deer browse. Univ. Minn. Forestry Note 42, 2 pp. (Processed.)  
(Tests indicate that overgrown stems of mountain maple may be effectively top-killed with 2,4-D esters in diesel oil and thus greatly increase the amount of regrowth available for deer browse.)



Stoeckeler, J. H.

Deer, mice, and hares damage young aspen and paper birch plantings in northeastern Wisconsin. L. S. Tech. Note 441, 1 p. (Processed.)

(Open-land plantings of wildling quaking aspen and paper birch may suffer damage from the white-tailed deer, snowshoe hare, and meadow vole. Most of the mortality occurring during a 3-year study was due to girdling by the meadow vole.)

#### Forest Survey

Chase, Clarence D., and Horn, A. G.

Timber resources, Cadillac Block, Lower Peninsula, Michigan. Mich. Cons. Dept. and Lake States Forest Expt. Sta., 53 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, allowable cut, and drain by species and kinds of timber.)

\_\_\_\_\_ and \_\_\_\_\_

Timber resources, Houghton and Keweenaw Counties, Michigan. Mich. Cons. Dept. and Lake States Forest Expt. Sta., 41 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, allowable cut, and drain by species and kinds of timber.)

\_\_\_\_\_ and Spurr, Stephen H.

Photo-interpretation aids. L. S. Misc. Report 38, 13 pp. (Processed.)

(A list of stereoscopes, area grids, etc., giving their source and cost, together with a brief description.)

Dickerman, M. B., and McGuire, John R.

\*Domestic supply of forest land and timber. Chap. II in Timber Resource Review, U. S. Forest Serv., 69 pp., illus. (Processed.) Prelim. review draft.

(Describes the distribution, ownership, condition, and trends of forest land area, and the amount, ownership, accessibility, quality, and trends in timber volume. A nationwide review, keyed to regional data.)

Guilkey, P. C., and Dickerman, M. B.

Minnesota's changing timber resources. The Conserv. Volunteer 18(106): 1-8, illus. Also Forest Prod. Jour. V: 112-114, illus.

(Summarizes the changes in forest type areas, timber volumes, growth, and timber cut in Minnesota that occurred between the first Forest Survey in 1936 and the Forest Survey completed in 1953.)

Horn, A. G.

Production of pulpwood continues at high level in the Lake States, 1954. L. S. Tech. Note 436, 2 pp. (Processed.)

(Shows production by species in Minnesota, Wisconsin, and Michigan; also imports from other states and Canada, and movement between states in the region. 9th of an annual series.)



\_\_\_\_ Cut of veneer logs increases in Minnesota, decreases in Wisconsin and Michigan, 1954. L. S. Tech. Note 442, 2 pp. (Processed.)

(Shows production by species in each of the Lake States; also imports from other states and Canada, and movement between states in the region.)

Office of Iron Range Resources and Rehabilitation and Lake States Forest Experiment Station.

The forest resource of Lake County, Minnesota. Iron Range Resources and Rehabil., 64 pp., illus.

(Presents forest areas, timber volumes, growth, allowable cut, and drain for the county.)

\_\_\_\_ and \_\_\_\_

The forest resource of Pine County, Minnesota. Iron Range Resources and Rehabil., 58 pp., illus.

(Forest areas, timber volumes, growth, allowable cut, and timber cut.)

\_\_\_\_ and \_\_\_\_

The forest resource of St. Louis County, Minnesota. Iron Range Resources and Rehabil., 71 pp., illus.

(Forest areas, timber volumes, growth, allowable cut, and timber cut.)

Wisconsin Conservation Department and Lake States Forest Experiment Station.

The forest resources of Chippewa County, Wisconsin. Wis. Conserv. Dept., 37 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, drain, and allowable cut in the county.)

\_\_\_\_ and \_\_\_\_

The forest resources of Eau Claire County, Wisconsin. Wis. Conserv. Dept., 35 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, drain, and allowable cut in the county.)

\_\_\_\_ and \_\_\_\_

The forest resources of Forest County, Wisconsin. Wis. Conserv. Dept., 32 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, drain, and allowable cut in the county.)

\_\_\_\_ and \_\_\_\_

The forest resources of Oneida County, Wisconsin. Wis. Conserv. Dept., 39 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, drain, and allowable cut in the county.)



\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Vilas County, Wisconsin. Wis. Conserv. Dept., 39 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, drain, and allowable cut in the county.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Adams County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Jackson County, Wisconsin. Wis. Conserv. Dept., 34 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Juneau County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Marquette County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Monroe County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Portage County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)

\_\_\_\_\_ and \_\_\_\_\_

The forest resources of Wood County, Wisconsin. Wis. Conserv. Dept., 36 pp., illus. (Processed.)

(Presents forest areas, timber volumes, growth, timber cut, and allowable cut in the county, and the results of reproduction survey.)



## Forest Economics, Utilization, and Marketing

Cunningham, R. N.

\*The public employer's viewpoint: What training in economics and business should the general forestry graduate have? Soc. Amer. Foresters Proc. 1954: 146-148.

(The student aiming at public employment needs some orientation in good business practices as one going into private work--has possibly wider choice of specializations demanding advanced training in economic theory.)

Dickerman, M. B.

\*Factors affecting future supply and quality of domestic timber: Forestry assistance programs. Chap. IV, Sec. F, of Timber Resource Review, U. S. Forest Serv., 13 pp. (Processed.) Prelim. review draft.

(Indicates the scope and some of the major accomplishments of public cooperative programs. Also describes briefly the assistance programs of some of the industry and conservation organizations.)

Godman, R. M., and Salminen, W. A.

Reduction of woods waste from periodic cuts--an index of stand improvement. L. S. Tech. Note 431, 2 pp. (Processed.)

(Describes the reduction in woods waste in successive cuts. The ratio of woods waste to net volume decreases as cull material is gradually eliminated from the stands by periodic cutting.)

Kaufert, F. H., Rees, L. W., and Neetzel, J. R.

Durability of pentachlorophenol treated fence posts. Univ. Minnesota Forestry Note 44, 2 pp. (Processed.)

(Thirteen-year service record presented for jack pine, white oak, red oak, white birch, cottonwood, and aspen posts set in School of Forestry, University of Minnesota, test plots.)

Morgan, J. T.

Log grades of Iowa timber. L. S. Tech. Note 443, 2 pp. (Processed.)

(Thirty percent of Iowa hardwood sawtimber volume is in log grades 1 and 2; elm, cottonwood, and walnut have higher than average grade.)

Quinney, D. N.

Log grades of Minnesota hardwoods. L. S. Tech. Note 435, 1 p. (Processed.)

(Presents log grade distribution for several major tree species as determined by field study.)

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Sawtimber quality in Michigan. L. S. Tech. Note 429, 2 pp. (Processed.)

(Presents log grade distribution for several major Michigan tree species as determined by field study.)



Williams, E. T., Dickerman, M. B., and Marquis, R. W.

\*Factors affecting future supply and quality of domestic timber: Financial and economic factors. Chap. IV, Sec. E, of Timber Resource Review. U. S. Forest Serv., 11 pp. (Processed.) Prelim. review draft.

(Discusses taxation, credit, and insurance problems of the forest landowner; a nationwide review.)

#### General

Dickerman, M. B.

\*The Lake States Forest Experiment Station: its work and organization. Lake States Timber Digest 9(5): 6-8 and 14.

(Describes the work conducted in each of the five major research programs, and methods of disseminating information; indicates some future research needs.)

Ralston, R. A.

\*The work of the Northern Lakes Research Center. Spec. Conserv. Issue of Forest County Republic, April 1955.

(Describes research program in the Station's Research Center in Wisconsin.)

Thames, John L., Stoeckeler, J. H., and Tobiaski, Robert.

Soil moisture regime in some forest and non-forest sites in northern Wisconsin. Soil Sci. Soc. of Amer. Proc. 19(3): 381-384, illus.

(The soil moisture regime was studied on two paired sets of sites: One pair on Spencer silt loam included a forested and a non-forested plot; the other pair were both forested plots on sands, but one plot had a permanent water table of 2.0 feet, the other 4.5 feet.)